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HUBBLE SPACE TELESCOPE THIRD SERVICING MISSION INTEGRATION AND TEST PLAN

MAY 1999

GODDARD SPACE FLIGHT CENTER
GREENBELT, MARYLAND

HUBBLE SPACE TELESCOPE FLIGHT PROJECTS

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Illustrations

Acronyms

ABS	Axial Bay Simulator
ACP	Astronaut Control Panel
ACS	Advanced Camera for Surveys
AIMS	Analytical Instruments Measurement System
AP	Application Processor
ARB	Anomaly Review Board
	SCN 001
ASCS	Aft Shroud Cooling System
ASIPE	Axial Scientific Instrument Protective Enclosure
ASIS	Axial Science Instrument Simulator
AT	Aliveness Test
BOB	Break Out Box
BOC	Break Out Cable
BRD	Bundled Retention Device
CARD	Constraints and Restrictions Document
CATs	Crew Aids and Tools
CCL	CCS Command Language
CCS	Control Center System
CEI	Contract End Item
CHEST	Cooling Hardware Environmental System Testbed
CITE	Cargo Integration Test Equipment
CMO	Configuration Management Office
CRF	Canister Rotation Facility
CS	Control Section
CSCOMM	Control System Communication
DCF	Data Capture Facility
DIU	Data Interface Unit
DMS	Data Management System
DPC	Direct Power Converters
DPM	Deputy Project Manager

Acronyms (Continued)

ECU	Electronic Control Unit
EGSE	Electrical GSE
EICIT	Electrical Interface Continuity and Isolation Test
EM	Engineering Model
EMI	Electro Magnetic Interference
EPS	Electrical Power System
ESD	Electrostatic Discharge
ESF	External Simulation Facility
ESM	Electronic Support Module
ESS II	Engineering Support System-2
ETE	End-to-End
EVA	Extra Vehicular Activity
FFF	Form, Fit, and Function
FGS	Fine Guidance Sensor
FHST	Fixed Head Star Tracker
FSIPE	FGS SI Protective Enclosure
FS&SP	Flight Systems and Servicing Project
FSS	Flight Support System
FSW	Flight Software
FT	Functional Test
GSE	Ground Support Equipment
GSFC	Goddard Space Flight Center
HAR	HST Anomaly Report
HARS	HST Anomaly Reporting System
HFMS	High Fidelity Mechanical Simulator
HOMS	Hubble Optical Mechanical Simulator
HST	Hubble Space Telescope

SCN 001

SCN 001

Acronyms (Continued)

I&T	Integration and Test
ICD	Interface Control Document
IVT	Interface Verification Test

Acronyms (Continued)

JSC	Johnson Space Center
KSC	Kennedy Space Center
LSIP	Launch Site Integration Plan
MCC	Mission Control Center
MEB	Main Electronics Box
MGSE	Mechanical GSE
MTL	multisetting torque limiter
MUF	Multi Use Fixture SCN 001
MULE	Multi Use Lightweight Equipment
NCC	NICMOS Cryogenic Cooler
NCS	NICMOS Cooling System SCN 001
NICMOS	Near Infrared Camera and Multi-Object Spectrometer
NMI	NASA Management Instruction
NOBL	New Outer Blanket Layer
NPE	NOBL Protective Enclosures
NSSC-I	NASA Standard Spacecraft Computer, Model-1
OGSE	Optical GSE
OLD	Operations Limitations Document
OPE	ORU Protective Enclosure
OPF	Orbiter Processing Facility
ORI	Orbital Replacement Instrument
ORU	Orbital Replacement Unit
ORUC	ORU Carrier
ORV	Orbital Reverification
OSMM	Operations Servicing Mission Manager
OTA	Optical Telescope Assembly

Acronyms (Continued)

PASS	POCC Applications Software Support
PCS	Pointing and Control System
PCU	Power Control Units

SCN 001

SCN 001

Acronyms (Continued)

PDB	Project Database
PDU	Power Distribution Unit
PGHM	Payload Ground Handling Mechanism
PHSF	Payload Handling and Storage Facility
PLBD	Payload Bay Door
PLCP	Planning Command Pool
PORTS	POCC Operations Realtime Support
PPF	Payload Processing Facility
PRD	Project Reference Data
PRS	PORTS Refurbishment System
PSTOL	PORTS System Test and Operations Language
R&I	Receiving and Inspection
RAC	Rigid Array Carrier
RBM	Radial Bay Module
RGA	Rate Gyro Assembly
RIU	Remote Interface Unit
RSIPE	RBM SI Protective Enclosure
RSU	Rate Sensor Unit
SA3	Third Solar Array
SAC	Second Axial Carrier
SADE	Solar Array Drive Electronics
SADM	Solar Array Drive Mechanism SCN 001
SAPC	Solar Array Power Console
SAW	Solar Array Wing SCN 001
SCA	Shuttle Carrier Aircraft
SI	Scientific Instrument
SIFIG	Scientific Instrument and FGS Installation GSE
SIPE	Scientific Instrument Protective Enclosure
SM3	Servicing Mission 3
SMGT	Servicing Mission Ground Test
SMIT	Servicing Mission Integrated Timeline

Acronyms (Continued)

SMS	Science Mission Specification
SOGS	Science Operations Ground System
SPAR-3	Standard Payload Assurance Requirements
SSAT	S-Band Single Access Transmitter
SSDIF	Space Systems Development and Integration Facility
SSE	Space Support Equipment
SSM	Support Systems Module
SSP	Standard Switch Panel
SSR	Solid State Recorder
SSRF	Shield Shell Replacement Fabric
ST ScI	Space Telescope Science Institute
STAR	Space Telescope Axial Replacement
STIS	Space Telescope Imaging Spectrograph
STOCC	Space Telescope Operations Control Center
TC	Test Conductor
UUT	Unit Under Test
VBS	VEST Battery Simulator
VEST	Vehicle Electrical Systems Test
VIF	Vertical Integration Facility
VIK	Voltage/Temperature Improvement Kit
VOCC	VEST Operations Control Center
VPF	Vertical Processing Facility
VPHD	Vertical Payload Handling Device
WOA	Work Order Authorization

TBD List

Item No.	TBD TBS	Location	Description	Resp.	Date

SCN 001

1. INTRODUCTION

1.1 PURPOSE

This document presents the Hubble Space Telescope (HST) Servicing Mission 3 (SM3) Integration and Test Plan for the NASA/Goddard Space Flight Center (GSFC), Code 442, HST Flight Systems and Servicing Project (FS&SP). The flight hardware test plan described in this document validates interface, functional, and system requirements that provide confidence in mission success.

1.2 SCOPE

The activities covered by this plan comprise the flight payload cycle from GSFC Receiving and Inspection (R&I) testing through payload launch and subsequent de-integration. This plan also addresses post-mission de-integration at GSFC. The SM3 I&T plan focuses on the technical approach and methodology for the system Integration and Test (I&T) of flight components into the HST Electrical System, Mechanical Simulator, and HST Ground System at GSFC. Test objectives, procedures, responsibilities, general hardware and software requirements, and support and facility requirements are defined. This document contains an overview of the activities at the launch site. Launch site activities are defined in more detail in the SM3 Launch Site Support Plan.

1.3 MISSION IDENTIFICATION

The HST Project is identified as a Class-B program in accordance with NASA Management Instruction (NMI) 8010.1A. A program of this type has a reasonable tradeoff between risk and cost because of a capability to recover by acceptable means from an in-orbit failure. GSFC imposes Standard Payload Assurance Requirements (SPAR-3) guidelines for HST replacement hardware and software. SM3 is the third in a series of scheduled and call-up missions that provide on-orbit servicing of the observatory support equipment and Scientific Instruments (SIs). Orbital Replacement Instruments (ORIs), Orbital Replacement Units (ORUs), the Space Support Equipment (SSE), and EVA Crew Aids and Tools (CATs) are manifested on this mission. ORIs are new, replacement, or upgraded SIs. ORUs are the components that provide the observatory with power, communications, data management, and tracking and pointing capabilities. The SSE accommodates the payload during flight and provides the capability for the mechanical support, control, and umbilical support of HST by the Orbiter during servicing and checkout. The CATs facilitate the removal, temporary storage (parking), translation, and installation activities associated with replacing ORUs and ORIs by the crew. Early in 1999 the SM3 Mission was divided into two separate missions identified as SM3A and SM3B. SCN 001

1.4 SM3A & B PAYLOAD DESCRIPTION

The SM3A Payload consists of:

ORUs

- HST 486 Replacement Computer
- Solid State Recorder (SSR)
- Fine Guidance Sensor/Radial Bay Module (FGS/RBM)
- Rate Sensor Unit (RSU)
- S-Band Single Access Transmitter (SSAT)

- Voltage/Temperature Improvement Kit (VIK)
- New Outer Blanket Layer (NOBL)
- Shield/Shell Replacement Fabric (SSRF)

SSE

- Flight Support System (FSS)
- ORU Carrier (ORUC)

EVA Crew Aids and Tools (CATs)

- Power Ratchet Tool
- Bi-Stem Braces
- Aft Fixture

The SM3B Payload consists of:

ORIs

- Advanced Camera for Surveys (ACS)
- Aft Shroud Cooling System/NICMOS Cooling System (ASCS/NCS)

ORUs

- Solar Array 3 (SA3) and Second Diode Box Assemblies (DBA2)
- Power Control Unit (PCU) SCN 001
- New Outer Blanket Layer (NOBL)

SSE

- Flight Support System (FSS)
- Rigid Array Carrier (RAC)
- Second Axial Carrier (SAC) SCN 001
- Multi Use Lightweight Equipment (MULE) Carrier

EVA Crew Aids and Tools (CATs)

- Power Ratchet Tool
- SI Parking Fixture

- Bi-Stem Braces

1.5 GSFC INTEGRATION TESTING OVERVIEW

The test flow at GSFC consists of up to six major types of flight hardware checkout, verification, and analysis (see Figure 1-1).

1.5.1 GSFC Activities

Flight hardware is inspected, cleaned as necessary, and moved into the clean room after delivery to GSFC. The hardware developer may run post-shipment tests before turning over primary responsibility to the GSFC I&T Team.

All critical mechanical interfaces and envelopes are verified prior to installation into Vehicle Electrical Systems Test (VEST) Facility, High Fidelity Mechanical Simulator (HFMS), or integration with other interface hardware such as Scientific Instrument Protective Enclosures (SIPEs) or ORU Protective Enclosures (OPEs). Fit checks are performed for interface cables, mounting hardware, the (SIPE), (OPEs), External Simulation Facility (ESF), and EVA CATs as appropriate.

Electrical tests start with interface testing consisting of continuity and isolation checks, electrical power, command, and telemetry interface checks.

Aliveness and Functional tests verify prime and redundant subsystem capabilities and operational modes of the flight hardware

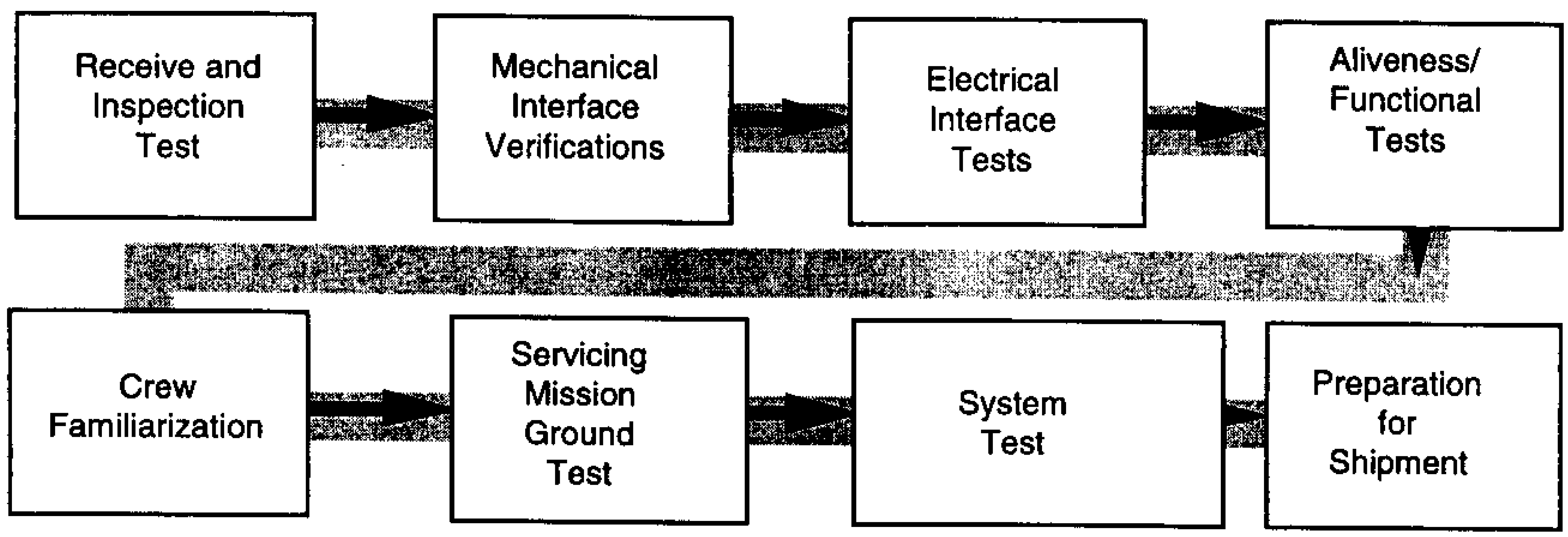

Figure 1-1. GSFC Major Integration and Test Activities

to the extent allowed by ground testing. These tests are performed with the flight unit electrically connected to the VEST facility.

During the I&T process, periods are set aside for crew familiarization of hardware including installation into and removal from protective enclosures, VEST, ESF, and the HFMS. Installation and removal practice is done with flight hardware and hardware simulators.

In conjunction with each series of replacement hardware tests, the Space Telescope Operations Control Center (STOCC) performs system level tests to verify commanding capability and telemetry handling. This is accomplished by execution of a Servicing Mission Ground Test (SMGT) for each flight item primary subsystem.

End-to-end ground system testing is performed from the STOCC with all SM3 replacement hardware except SA3 Wing assemblies, integrated into the VEST Facility. The Solar Array Power Console (SAPC) simulates the SA3 wing assemblies due to their size and passive function.

The System Compatibility Test is performed by the VOCC with the VEST Structure configured to replicate the HST in its post-servicing mission observatory configuration. The purpose of this test is to verify that the new replacement hardware will be compatible with the HST observatory and will functionally perform in the system environment as it is intended to be used. This process validates that all mission hardware works as an integrated system with all other elements of the HST, the flight software, the ground system and databases.

The flight hardware undergoes pre-shipment tests prior to shipment to the launch site. Upon successful completion of all testing and the pre-shipment review at GSFC, the hardware is packed and shipped to KSC.

1.5.2 KSC Activities

The SIs, ORUs, and SSE are inspected and any necessary cleaning performed. Post-shipment testing and final flight configuration closeout are completed. The replacement units are integrated into the respective protective enclosures and carriers as required. If a CITE test is required, the SSE with ORUs and ORIs is installed into a test cell in the Vertical Processing Facility (VPF). CITE test is performed between the SSE and Orbiter simulation equipment. The payload is moved to the launch pad and integrated into the Orbiter. An Orbiter Interface Verification Test (IVT) and End-To-End (ETE) tests are performed with the integrated payload at the pad.

1.5.3 On-Orbit Activities

Members of the GSFC I&T Team provide support during the launch and on-orbit servicing activities under the direction of the Servicing Mission Manager. Participation of these personnel is required in the Mission Control Center (MCC) at the Johnson Space Center (JSC), GSFC STOCC, the VEST Facility, and at the launch site. During launch and the on-orbit mission, these personnel serve in advisory and analytical support roles.

1.5.4 De-integration Activities

After the Orbiter returns to the Orbiter Processing Facility (OPF), the KSC Team is responsible for removal of the payload from the Orbiter and transporting it to a payload processing facility. The GSFC I&T Team de-integrates the payload and prepares the payload for shipment to GSFC.

The returned hardware is removed from the SIPEs and OPEs as required. The SIs and ORUs are de-integrated and undergo extensive contamination inspection. The flight hardware is returned to the responsible hardware managers for further evaluation and disposition.

1.6 REFERENCE DOCUMENTS

The following documents were used as sources for requirements and technical information in the development of this plan:

Document Number	Document Title
N/A	Engineering Services Division Safety Manual
FED-STD-209D	Clean Room and Work Station Requirements, Controlled Environment
GEVS-SE Rev. A January, 1990	General Environmental Verification Specification For STS and ELV Payloads, Subsystems and Components
GMI 1700.3A	System Safety for Orbital Flight Projects
GMI 1710.6	Design, Inspection, and Certification of Lifting Devices and Equipment
ICD 2-19001	Shuttle Orbiter/Cargo Standard Interfaces

Document Number	Document Title
ICD-A14009-SM	Shuttle Orbiter to HST SM Cargo Element Interface Control Document
KHB 1700.7B	NASA KSC/CCAFS Space Shuttle Payload Ground Safety Handbook
LMSC/P106546	HST FS&S Health and Safety Plan
LMSC/P016262A	EMI Test Plan
NHB-1700.1	NASA Safety Policy and Requirements Document
NSS/GO-1740.9	NASA Safety Standard for Lifting Devices and Equipment
P-442-0704	HST Servicing Mission Contamination Control Master Plan
P-442-0770	HST Work Order Procedure
P-442-0785	Standard Operating Procedures for Flight Systems and Support Integration and Test
P-442-0786	FS&SP Standardized I&T Procedure Guide
P-442-0787	FS&S Project HST Anomaly Reporting System Procedure
P-442-2183	Hubble Space Telescope Third Servicing Mission Photo Documentation Plan
PIP Annex 8	HST Servicing Mission Launch Site Support Plan
PIP Annex 9	HST Servicing Mission Payload Verification Requirements
SCM-1020	HST Flight Projects Configuration Management Plan
SMO-1020	Constraints and Restrictions Document
SMO-1060	SI C&DH and SI Thermal Constraint/Action Value Document
SMO-1080	HST VEST CARD
SMO-1090	Operations Limitations Document

Document Number	Document Title
SMR-3022	HST SM3 EVA Verification Plan
SMR-3060	HST SM Management Plan
SPAR-3	Standard Payload Assurance Requirements for STS and ELV Payloads and Instruments
SPS-2703	Cleaning, Handling, and Storage - Space Shuttle ST/LS
ST-ICD-01	HST Level II Interface Control Document, Support Systems Module to Optical Telescope Assembly
ST-ICD-02(E)	HST Level II Interface Control Document, Axial Scientific Instrument to the Optical Telescope Assembly and the Support Systems Module
ST-ICD-08	HST Level II Interface Control Document, Scientific Instruments to Scientific Instruments Control and Data Handling System
ST-ICD-10	HST Level II Interface Control Document, HST to Space Support Equipment
ST-ICD-91	Axial Scientific Instrument to Space Support Equipment Interface Control Document
ST-ICD-97	HST Orbital Replacement Unit to Space Support Equipment Interface Control Document
ST-ICD-98	Aft Shroud Cooling System/NICMOS Cooling System to HST Interface Control Document
ST/SE-02	Space Telescope Systems Description Handbook
STE-43	HST SM3 Crew Aids and Tools Design and Verification Specification
STR-02D	HST Level II Requirements Document, Scientific Instrument to the Optical Telescope Assembly and the Support Systems Module

Document Number	Document Title
STR-27	HST COSTAR Performance Assurance Requirements
STR-29	HST Servicing Mission Contamination Control Requirements
STR-80	SM3 Level II Requirements
STR-81	HST SM3 FS&S Level III FS&SP Requirements
VOPO-0003	VEST Operations Contingency Plan
VPPL-0001	HST-G VEST ESD Control Requirements and Implementation Plan

2. INTEGRATION AND TEST ORGANIZATION

2.1 ORGANIZATIONAL STRUCTURE

SM3 activity falls under the direct control of the Deputy Project Manager (DPM) as shown in Figure 2-1. The DPM supports a Verification Team chaired by the Deputy Associate Director of Flight Projects for HST.

The Integration and Test Manager, in direct control of all I&T activity, leads a core team of key personnel. Each flight hardware element test activity is executed under the overall direction of a Test Director. Test teams are established to perform each I&T activity.

2.2 ORI/ORU/SUBSYSTEM INTEGRATION AND TEST TEAMS

The development contractor or organization delivers each ORI and ORU to the FS&SP and the respective I&T Team. Members of development teams are an integral part of the I&T Teams. Key personnel for each test are listed in the appropriate procedure. A generic representation of the ORI/ORU/Subsystem I&T Team is shown in Figure 2-2.

The Test Director is in overall charge of the unit under test (UUT) and the supporting elements. The Test Director reports to the I&T Manager, and coordinates with the I&T Systems Engineer and Test Conductors in preparing for and executing tests. The ORI/ORU Subsystem Manager has the direct responsibility for the readiness, health, and welfare of the UUT during testing

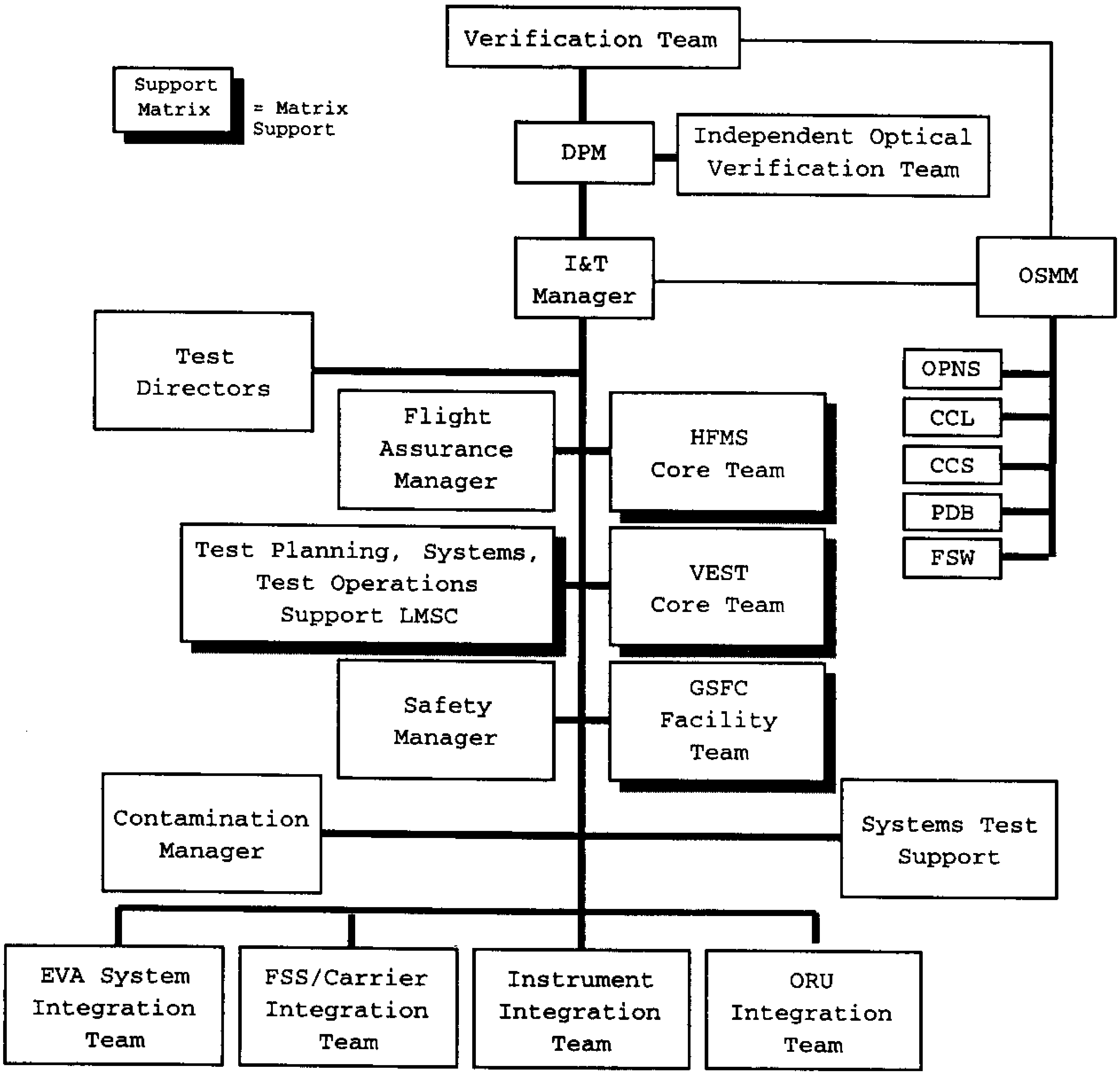

Figure 2-1. FS&SP Test Organization Chart

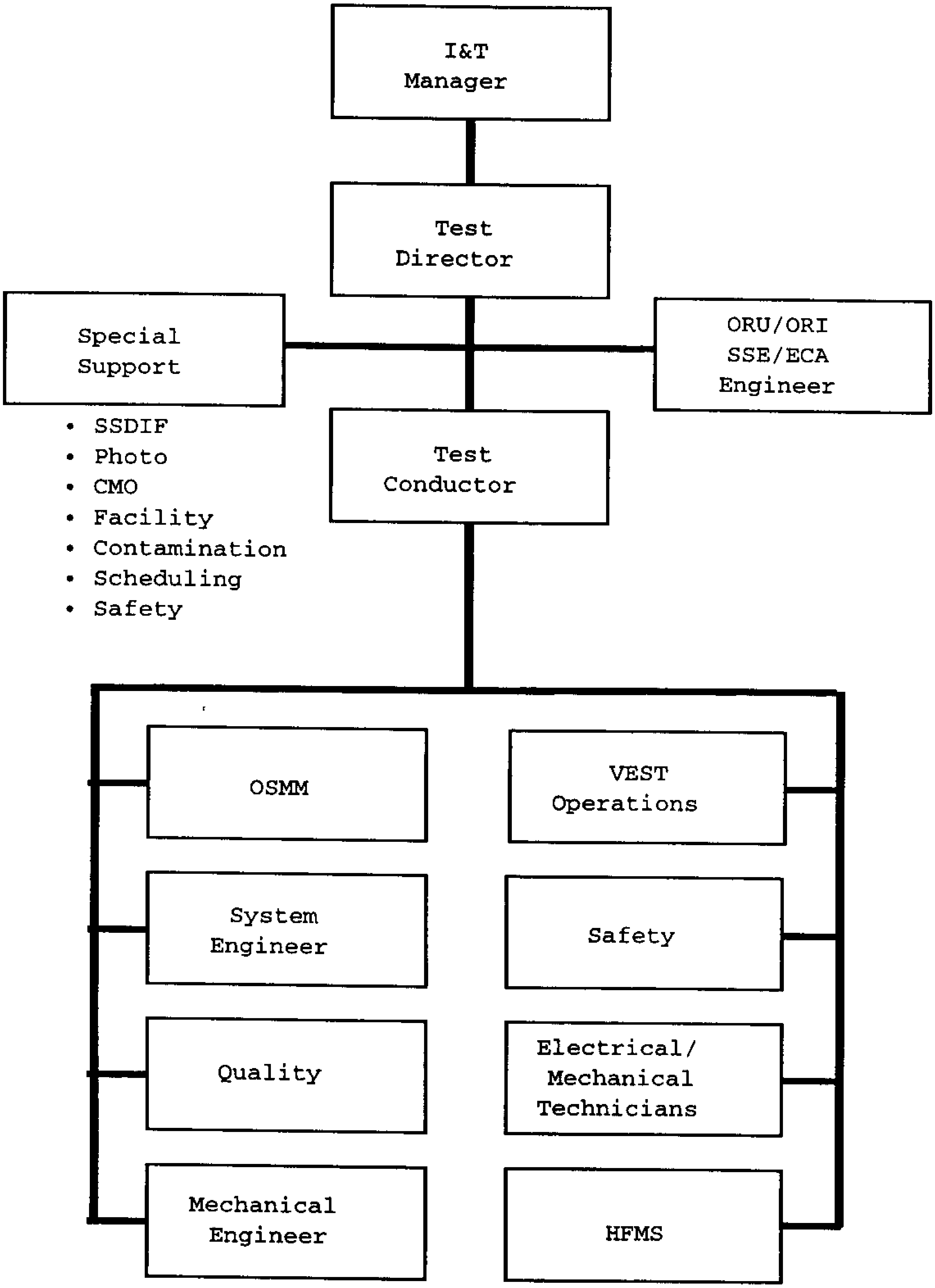

Figure 2-2. ORI/ORU Integration and Test Team (Generic)

including data evaluation and the investigation and resolution of anomalies.

Each team includes a Test Conductor (TC) who is totally familiar with the operation of the UUT and the operation of the associated major Ground Support Equipment (GSE), simulators, and ORI/ORUs. Prior to delivery of the ORI or ORU, the TC has worked with the I&T Team to formulate the procedures.

3. MANAGEMENT

3.1 ADMINISTRATIVE CONTROLS

Verification of safety and quality requirements, ground systems verification, flight system integrity, and Crew Familiarization are fundamental to the success of the mission. These objectives, the most important of which is to ensure the safety of personnel and hardware, are accomplished by the implementation of various control measures.

3.1.1 Reviews

Pre-test reviews that address the readiness of flight hardware, test equipment, facilities, test personnel, and procedures precede all tests of flight hardware. Pre-test reviews are conducted by the key ORI/ORU test personnel and approved by the I&T Manager. An overall I&T readiness review is held prior to the initiation of actual testing of any SM3 hardware under the I&T program.

Following flight hardware tests, post-test reviews are held during which test data is reviewed to determine conformance with performance requirements. The review is led by the I&T Manager and supported by key personnel from the Core I&T Team and each ORI/ORU Subsystem team. In addition, daily test team meetings are held by the I&T manager to coordinate test activities and manage test discrepancies.

Prior to shipment of any equipment to the launch site a pre-ship review is conducted by the GSFC Systems Review Office. The pre-ship review examines the total test record of each SM3 flight hardware element. Test records are presented by the Project, concentrating on open anomaly reports.

3.1.2 Documentation Requirements

Throughout all phases of I&T approved procedures are developed and used. The documentation required to perform the I&T activities described in this plan is reviewed by the flight hardware development organization representative and the ORI/ORU Subsystem Teams prior to the performance of the procedure. Development organizations are responsible for availability of technical documentation, including drawings and other descriptive data, development test plans and procedures, and the history of tests and anomalies. Each I&T Team is responsible for development of test procedures. The DPM Verification team at their discretion may review all procedures and results.

3.1.2.1 Procedures. Objectives, prerequisites, methodology, unique safing procedures and hazard controls, facility requirements, and equipment requirements are specified in each electrical and mechanical procedure in accordance with the FS&SP Standardized I&T Procedure Guide, P-442-0786. Each procedure also includes the configurations, contamination control, personnel required, detailed step-by-step methodology, measurements to be made, data to be acquired and the pass/fail criteria. Automated test "procs" (PSTOL or CCL procedures) are identified by their respective unique mnemonic and includes operator instructions for activation, and if needed, operator responses.

All procedures must receive concurrence by the corresponding ORI/ORU Subysytem Team Manager and the Test Team Systems Engineer. Approval of each procedure is required by the I&T Manager, Flight Assurance Manager, and the Test Director. Once approved, procedures (including the associated software) are under control of the appropriate Configuration Management Office (CMO). The Test Director, Flight Assurance Manager, and key managers approve, in writing, deviations to test procedures before continuing the test. Redlining of test procedures is performed as required, with appropriate approvals, to reflect the most current situation A Quality Assurance Engineer witnesses performance of all tests. The test procedure includes objectives, required output, and criteria for determining acceptability of results for each analysis required as part of the test process.

During execution of VEST procedures, contingency operations are governed by the VEST Operations Contingency Plan (VOPO-0003). This document defines all contingency operations, such as test shut down due to weather or other environmental conditions.

3.1.2.2 Work Order Authorization. All work is done by approved Work Order Authorization (WOA). The WOA is to be generated and approved in accordance with the "Hubble Space Telescope Work Order Procedure" (P-442-0770).

3.1.2.3 Test Reports. After completion of each test, the Test Conductor provides a test report. The report summarizes the test results, data analyses, test configuration, test team conclusions, and if applicable, the status of all anomalies encountered during the integration and test process. The "As-Run" test procedures and all data generated during execution of the procedure become part of the test report. Test reports are published with-in two weeks of test completion.

3.1.2.4 Anomaly Reports. All anomalous conditions are documented in accordance with the HST Anomaly Reporting System (HARS) document (P-442-0787) on a HST Anomaly Report (HAR) form. These reports document and track individual anomalous events and the approved resolution. HARS is designed to support all elements of Code 442 activities at GSFC and KSC. The cognizant GSFC/Code 442 Office Head assembles an Anomaly Review Board (ARB). The ARB chairperson has responsibility to resolve HARs and provide status to the GSFC/Code 442 Office Head. Anomalies fall into two classifications: major and minor. Major anomalies are those that impact cost, schedule, or interface. All others are considered minor anomalies. The closure of a major anomaly requires review and approval by the 442 Deputy Project Manager. A minor anomaly can be closed by the ARB.

3.1.2.5 Hardware Log Books. Hardware log books are generated and maintained by the Flight Assurance Group. WOAs, procedures, test reports, summaries of operational hours and power cycles, and anomaly reports are included as official records with the Hardware Log Books. The log books present a chronological history of all information pertinent to individual flight items. The corresponding log book remains with the hardware throughout the entire flight preparation. This documentation is available for review upon request at the hardware location.

3.1.3 Performance Verification Requirements

Performance requirements are derived from the Contract End Item (CEI) Specification and Interface Control Document(s) (ICD) for each UUT. The performance verification requirements are also traceable to the Level I requirements documents.

During typical flight system integration at GSFC, the complete spacecraft is assembled and tested in a "build-up" process that results in a substantial amount of regression testing of components in the system environment. For the Servicing Mission, the VEST provides a high fidelity test bed where performance and compatibility at the system and Observatory level are thoroughly demonstrated. The HFMS provides the facility for checking mechanical interfaces of the ORIs and ORUs.

Starting with test results delivered by the developer a test database is maintained by the appropriate hardware manager throughout the I&T activity. This database is used as a baseline for comparison of results from subsequent tests and operations. Since all flight hardware is fully qualified and tested prior to delivery to GSFC, no environmental tests are included in the I&T process.

3.2 HANDLING, TRANSPORTATION, AND STORAGE REQUIREMENTS

Handling, transportation, and storage equipment provide protection for the ORIs/ORUs, GSE, SSE, and CATs during all phases of transportation and handling of the flight hardware. Requirements for this equipment are imposed in accordance with STR-02D, ST-ICD-01, ST-ICD-02E, and ST-ICD-97. Unique requirements for specific hardware are listed in the corresponding subsection of this document.

3.3 ENVIRONMENTAL CONTROL REQUIREMENTS

All ground tests are performed under ambient temperature (65°F to 75°F) and pressure conditions. Relative humidity is maintained between 30 percent and 50 percent. Temperature, humidity, and pressure requirements are defined in STR-02D. Hardware-specific environmental conditions imposed during GSFC I&T activities conform to the requirements described in the corresponding hardware subsection of this document.

3.4 CONTAMINATION CONTROL REQUIREMENTS

All Servicing Mission flight equipment is protected from contamination in accordance with the Hubble Space Telescope Servicing Mission Contamination Control Requirements, STR-29 and ST-ICD-02E.

All personnel handling flight equipment are trained in clean room practices. Hardware-specific contamination control requirements are described in the corresponding hardware subsection of this document. Unique contamination control requirements are also included in individual procedures where appropriate.

3.5 SAFETY REQUIREMENTS

All testing and handling of flight equipment conforms to the constraints and restrictions of the HST Constraints and Restrictions Document (CARD, HST Operations Limitations Document (OLD, and the HST VEST CARD. All employees are cognizant of the on-going fire, accident, and injury prevention policies for I&T activity at GSFC set forth in the HST FS&S Health and Safety Plan, LMSC/P106546 and the Engineering Services Division Safety Manual. Safety surveillance for mission critical hardware is maintained throughout the entire I&T program. Specific measures to minimize risk to personnel and equipment are included in the procedures. A hazards analysis is performed prior to initiation of activity that may have a high degree of risk. As a general rule, written procedures govern all payload activity. Only qualified and, as appropriate, certified personnel are involved in these activities. If hazards are identified they are documented and brought to the attention of the I&T Manager and Code 442 Safety personnel. The Test Conductor has the authority to order an emergency shutdown or safing of the VEST Facility in the event that safety is compromised. All lifting equipment used to lift flight hardware is certified by Code 442 personnel prior to the actual lift. Hardware-specific safety requirements are described in the corresponding hardware subsection of this document. Unique safety requirements are also included in individual procedures where appropriate.

3.6 PHOTOGRAPHIC/VIDEO REQUIREMENTS

Photographs and video documentation, as specified by the TC in the appropriate procedure or work order, document the hardware and all pertinent aspects of the procedure. Photographic and video requirements are defined in the Hubble Space Telescope Third Servicing Mission Photo Documentation Plan (P-442-2183).

The TC is authorized to require documentation of special activities or anomalies.

3.7 QUALITY ASSURANCE

Quality Assurance is implemented by use of established systems organized and structured in compliance with the requirements set forth in the HST COSTAR Performance Assurance Requirements and in Performance Assurance Requirements for the Satellite Servicing Project documents. These requirements impose the implementation and maintenance of a product assurance and safety program that encompasses all hardware and software (flight and ground systems) that interface with flight systems and all launch site activities.

3.8 PERSONNEL TRAINING REQUIREMENTS

Personnel performing certain hands-on types of work such as soldering, crimping, operation of cranes and forklifts, etc. are required to have the prescribed training courses and to be in possession of current certifications.

All members of the I&T Team having direct physical contact with flight hardware are required to have completed the appropriate Electrostatic Discharge (ESD) training and to be familiar with GSFC ESD requirements as detailed in VPPL-0001.

3.9 FACILITY ACCESS REQUIREMENTS

Personnel supporting the servicing mission payload activity require authorization for access to the facilities where the activities occur through the Project Support Manager.

3.9.1 Goddard Space Flight Center

A list of personnel permitted access to each controlled area is maintained by the facility manager. The facility manager arranges any necessary screening or other measure as required by the Project. In those areas where I&T activities are ongoing, the Test Director has complete authority over the flight hard-are and test systems and may deny access to or cause the removal of any person. the authority of the test director is necessary to protect flight systems and to ensure personnel safety.

3.9.2 Kennedy Space Center

All members of the team selected for launch site support and any personnel in on-call status require access to the center. Various facilities at KSC (e.g., Vertical Processing Facility, Orbiter Processing Facility, Launch Pad, etc.) require "Temporary Access Authorization" badging. This badging requires training for the various facilities, proper clearance, and Project determination for escort or no escort required.

3.10 REQUIREMENTS FLOW DOWN AND VERIFICATION

Mechanical interfaces defined in SM3 flight hardware interface control documents are verified. OTA-to-SSM interfaces for the Axial SI envelopes and FGS envelopes are also verified.

"Off-the-shelf" spares and other equipment originally designed for the initial HST deployment mission are covered by the product assurance requirements under which the equipment was originally produced. This I&T Plan descends from the Product Assurance requirements and the Level I, II, and III System Requirements Documents.

System requirements are defined in the Level I, Level II, and Level III Requirements Documents. The SM3 Level II Requirements Document, STR-80, and SM3 Level III Requirements Document, STR-81, calls out the system-level verification requirements that are the basis for this Integration and Test Plan.

4. GSFC GROUND SUPPORT EQUIPMENT

4.1 VEHICLE ELECTRICAL SYSTEM TEST FACILITY

The VEST Facility provides a high fidelity electrical simulation of the HST to which SM ORUs and ORIs are mated for ground verification of system operation and compatibility. VEST also provides a mechanical simulator for fit checking various test articles. The I&T activities performed in the VEST Facility provide confidence in the success of on-orbit installation and system operation of new hardware.

4.1.1 Electrical Test Support

The VEST structure consists of the Support Systems Module (SSM) and Optical Telescope Assembly (OTA) electrical equipment section, various power and telemetry simulators, and the VEST Operations Control Center (VOCC). The SSM and OTA simulate the HST flight electronics for the Data Management System (DMS), Electrical Power System (EPS), and Pointing and Control System (PCS).

The VEST Facility simulators provide power and simulated telemetry to the VEST structure for various HST subsystems. The VOCC provides commanding and data collection capabilities including the NASCOM interface. The VEST structure can be electrically connected to the HFMS when ORIs and ORUs are mounted on the mechanical simulator. The VEST Facility is capable of operating independently, utilizing the VOCC, or may be operated remotely from the STOCC. The Space Telescope Science Institute (STScI) may also be placed on line via the STOCC.

4.1.2 VEST Software Test Support

All flight software (FSW) is tested at GSFC to the extent allowed by ground limitations. The flight versions of the following software are used during various stages of testing:

- Control Center System (CCS)
- CCS Command Language (CCL)
- Program Reference Database (PRD)
- PORTS Refurbishment System (PRS)
- POCC Operations Real-time Support (PORTS)
- PORTS System Test and Operations Language (PSTOL)
- POCC Applications Software Support (PASS)
- Project Database (PDB)
- Data Capture Facility (DCF)
- Science Operations Ground System (SOGS)
- Engineering Support System-2 (ESS II)
- NASA Standard Spacecraft Computer, Model-1 (NSSC-I)
- DF-224/COP FSW
- HST486 FSW
- Planning Command Pool (PLCP)

All commands are approved and certified by GSFC and, if applicable by the vendor, prior to use with flight hardware on VEST. Version (release) numbers are detailed and reviewed in pre-test readiness meetings. The version number is specified in the appropriate test procedures.

During all phases of GSFC testing, all commands, telemetry verifiers, PSTOLs, CCLs and PLCPs are tracked in a matrix to assure that all PDB items (subject to ground test restrictions) are tested. All PSTOL/CCL procedures or command blocks are certified prior to use with flight hardware. Commands that cannot be tested are audited. All functional test procedures for VEST use the PSTOL procedures, CCL procedures, or PLCP command blocks developed at the Science Institute for Science Mission Specification (SMS) use.

4.1.3 Mechanical Test Support

The VEST SSM and OTA equipment bays have been upgraded as close to flight-like as possible to provide fidelity for crew familiarizations and hardware fit checks. VEST demonstrates the on-orbit configuration the astronauts encounter during changeout operations. Evaluations of reach and access (visual and manual), hardware and cable clearances, and tool use are supported.

4.2 HIGH FIDELITY MECHANICAL SIMULATOR

The HFMS is a precision mockup of major mechanical and electrical elements of the OTA, developed for use in demonstrating mechanical and electrical interfaces of ORIs and ORUs on HST. The HFMS includes the Telescope main ring simulator, focal plane structure, instrument mounting provisions (including flight latches), and the aft shroud assembly. In addition to mechanical fit checks, the HFMS provides the capability to familiarize the Astronauts with ORI/ORU replacement during the Extra Vehicular Activities (EVA) phases of the Servicing Mission.

4.3 MECHANICAL SIMULATORS, MECHANICAL GSE, TOOLING

Mechanical GSE (MGSE) is used to facilitate the mechanical and manual operations. This type of GSE includes lifting devices, work platforms, volume and mass simulators, and calibration devices. Slings, spreader bars, dollies, and other special purpose lifting equipment are used to move or install an ORI/ORU into the VEST structure, HFMS, or the appropriate protective enclosure. Work platforms include scaffolding and work tables arranged to provide easy access to components under test. Various mass and volume simulators are used for fit checks and changeout practice by astronauts. Fixtures are used to align or calibrate latch placements on SIs or the support dolly.

4.3.1 Analytical Instruments Measurement System

The Analytical Instruments Measurement System (AIMS) is used by NASA/GSFC Code 700 to measure the external envelopes of the flight hardware. Laser measuring equipment tied to a computer calculates the relative positions of points on the flight hardware to a given reference axis. The ACS external envelopes, latch locations and orientations, and guide block mechanical dimensions are verified by the AIMS prior to shipment to GSFC. Once at GSFC, the AIMS is used to verify the envelopes in regions that were not measured by the vendor or areas that changed since the initial measurements were taken.

4.3.2 Axial Scientific Instrument Simulator

The Axial Science Instrument Simulator (ASIS) is the primary reference tool for installing latches on the focal plane side of an interface, such as the Hubble Optical Mechanical Simulator (HOMS) or the ASIPEs. The ASIS and ABS constitute the mechanical reference standards for both sides of the latch interface and are used as required to verify metrology relating to the flight instruments.

4.3.3 Axial Bay Simulator (Quarter Panel)

The Axial Bay Simulator (ABS) or quarter panel is a surrogate one-quarter of a focal plane structure with latches. This fixture is used as a primary standard referencing for the three axial latches back to the HST focal plane optical axis.

4.3.4 NICMOS/ACS Volume Simulators

The volume simulators are an accurate representation of the external sweep volume of the SIs. These simulators are used to verify the HFMS bays before the actual flight instrument is installed. The simulators are equipped with "end plates" similar to those supplied with the flight unit to verify the ground handling procedures.

4.3.5 Scientific Instrument and FGS Installation GSE

Scientific Instrument and FGS Installation GSE (SIFIG) is a system of two orthogonal beams, each with remotely driven balance weights, used to lift the SI or FGS in a neutral balanced condition from a single hook point for installation into or out of the HFMS. Positioning the balance weights at previously calculated positions allows the SI to be installed into the HFMS without imposing loads into the SI rail guide system. When the SI is installed and secure in the latches, repositioning the weights transfers the 1g load of the SI into the latches and allows SIFIG to be removed. SIFIG was originally designed by MSFC to install the original SIs into the HST, because the allowable loads into the rail system were driven by the 0g requirements of on-orbit changeout and cannot withstand the 1g load on the ground.

4.3.6 Space Telescope Axial Replacement

Space Telescope Axial Replacement (STAR) is a dummy instrument that is flown in the event that one of the instrument complement is not ready for launch. It is also used to verify the available sweep volume in the ASIPE prior to installation of the flight instrument. STAR has been installed in each of the HFMS bays. It is the same size and uses the same flight latch system as the first complement of SIs. Note that due to changes in the ICD, STAR is larger than any of the new SIs.

4.3.7 Horizontal Lift Sling

The Horizontal Lift Sling (provided by the vendor) is a dedicated four-point lift sling designed to lift ACS in its horizontal position. This sling is used to remove the SI from the dolly for installation into the SIPE, and other handling as required.

4.3.8 External Simulation Facility

The External Simulation Facility (ESF) is a mechanical fixture in two parts: one that simulates the Light Shield/Forward Shell external features and another that simulates the Support System Module Equipment Section (SSM-ES) Bays 5-10 external features. The ESF is used for fit checks of the NOBL and SSRF ORUs being developed for SM3. The ESF will also be used for crew training for the NOBL and SSRF as well as other tasks as necessary.

4.4 ORI/ORU GSE

Each ORI/ORU is delivered with certified GSE. The hardware-specific GSE is described in the appropriate hardware section of this document. The types of GSE include MGSE, Electrical GSE (EGSE), and Optical GSE (OGSE). MGSE consists of handling fixtures, turnover dollies, lifting sling assemblies and any fixtures needed for alignment processes. EGSE includes equipment capable of powering the ORI/ORU, generating commands and automated test procedures, and acquiring the engineering and scientific data. OGSE is any equipment required to stimulate the instruments by generating and conditioning an optical beam and delivering it to the instrument aperture.

5. GSFC INTEGRATION AND TEST FLOW

5.1 INTEGRATION AND TEST ACTIVITY DESCRIPTION

All ORIs, ORUs, SSE, and CATs are flight qualified and acceptance tested prior to delivery. The GSFC I&T process does not include environmental tests. The scope of I&T comprises interface verification and system-level functional testing in the ambient environment of the Space Systems Development and Integration Facility, Building 29, at NASA/GSFC in Greenbelt, Maryland. Table 5-1 lists the tests performed for each flight item. Appendix A "SM3 I&T Verification Requirements" identifies the SM3 requirements.

5.2 RECEIVING AND INSPECTION TEST

Upon delivery to GSFC, each ORI, ORU, CATs, and SSE undergoes a thorough inspection and document check including validating the mechanical interfaces against the drawings. Examples of documentation requirements include schematics, parts and materials lists, interface drawings, command and telemetry lists, certification logs, anomaly reports and dispositions, operating instructions, weight and center of gravity certification, safety documentation, etc. The flight hardware and supporting GSE is un-packed and undergoes R&I. The I&T Team, consisting of mechanical engineers, hardware representatives, and flight assurance representatives, perform the R&I in accordance with approved procedures. These procedures, as a minimum, identify unpacking requirements, hand-ling constraints, mechanical tasks, responsibility, facilities, GSE, and safety constraints. A post-shipment functional test for the SIs is run by the hardware developer using the vendor's GSE with I&T Team support before final acceptance for GSFC integration. The purpose of this test

Table 5-1 Flight Hardware Tests

Hardware	R&I Test	Mechanical Interface Test	Electrical Interface Test	AT/FT Test	Crew Fam / CATs	System Level Test	Ground System Test
ACS	X	X	X	X	X	X	X
SA3/DBA2	X	X	X	X	X	X	X
HST 486	X	X	X	X	X	X	X
FGS/RBM	X	X	X	X	X	X	X
SSR	X	X	X	X	X	X	X
RGA	X	X	X	X	X	X	X
ASCS/NCS	X	X	X	X	X	X	X
VIK	X	X	X	X	X	X	X
NOBL	X	X	–	–	X	–	–
SSRF	X	X	–	–	X	–	–
SSAT	X	X	X	X	X	X	X
FSS	–	X	X	X	X	X	–
ORUC	–	X	X	–	X	–	–
RAC	–	X	–	–	X	–	–
MULE	–	X	X	–	X	–	–
ASAC	–	X	X	–	X	–	–
SIPEs	–	X	–	–	X	–	–
OPEs	–	X	–	–	X	–	–
PCU	X	X	X	X	X	X	X

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is to detect any shipping damage and to screen out any problems prior to interfacing with the integration facilities.

5.3 MECHANICAL VERIFICATIONS

Envelope and critical mechanical interfaces are inspected and measured by the GSFC team and the hardware developer per approved procedures. All handling procedures will be approved prior to use with flight hardware. These procedures will include responsibilities, facilities, weight and center of gravity data, flight hardware handling constraints, lifting or moving equipment certification by QA and safety, and associated contamination control provisions.

Mechanical simulators will be used to fit check the protective enclosures prior to integration of the flight hardware. The procedures used to fit check these simulators will be the basis for fit checking and integration of the ORIs and ORUs to the carriers. Integration and removal procedures must be approved prior to use.

The flight hardware is then mechanically integrated into the VEST structure or HFMS to verify cables/connectors, mounting surfaces attachment hardware, and clearances between replacement hardware and other HST components. Unique mechanical operations are noted in the corresponding hardware subsection. Fit checking of the SIs and ORUs in the HFMS and VEST mock-ups will be controlled by approved procedures. All equipment, responsibilities, facilities, flight hardware constraints, and safety provisions must be in place and approved prior to testing.

Crew familiarization tests will be performed at different stages of the hardware integration and fit checking activities. Prior to the crew familiarization tests, the cognizant engineers must verify all crew related mechanical interfaces.

5.4 CREW FAMILIARIZATION

Crew Familiarization involves Orbiter crew participation in flight hardware integration and testing of ORUs, ORIs, SSE, and CATs at GSFC, KSC, and vendor sites. This allows the crew frequent access and exposure to the HST SM3 payload and EVA interfaces. These activities are scheduled as part of the JSC crew training process. STR-81 states that "crew familiarization exercises shall be conducted using high fidelity one-gravity simulators and flight hardware." During the initial GSFC Crew Familiarization exercises, the crew installs and removes mechanical simulators and engineering models using the HFMS and VEST prior to performing installation and removal with flight hardware. The mechanical interfaces and worksite envelopes of the VEST, ESF, and HFMS duplicate the HST envelopes. The VEST and HFMS verify the mechanical fit of the flight hardware with HST interfaces. The crew gains familiarity with EVA interfaces by participating in EVA Form, Fit, and Function (FFF) tests that are part of the verification process. The crew is not required to participate in the EVA verification process, but to become knowledgeable of the CATs hardware and EVA flight interfaces.

5.5 ELECTRICAL INTERFACE TESTS

Prior to mating, an Electrical Interface Continuity and Isolation Test (EICIT) is performed on all ORI/ORU connectors and harnesses to verify that the interfaces are built as designed. The EICIT is followed by an Interface Verification Test (IVT) that checks for the presence of voltage and control signals on the appropriate lines and characterizes the levels and timing on those lines.

5.6 ALIVENESS TEST

The Aliveness Test (AT) that is executed in VEST (A- and B-side) for each ORI and ORU is the same health and status check as run on-orbit (one side only) to verify flight hardware interface capabilities. The power-up capability check configures the UUT to a known powered-off state and verifies the transition to a powered-on state while integrated to the VEST. The commanding capability check verifies that flight hardware primary and redundant subsystems (VEST only) accept and respond to configuration commands. The AT also demonstrates the telemetry monitoring capability by verifying the capability of the flight hardware to output telemetry.

5.7 FUNCTIONAL TESTS

The Functional Test (FT) that is executed in VEST (A- and B-side) for each ORI and ORU is the same subsystem functional test run on-orbit (one side only). The FT is a system-level test designed to demonstrate that the flight hardware meets all mission critical performance requirements. This is a full test of the capabilities of the hardware, firmware, and the flight software subject to a time limitation imposed by the shuttle environment. Major functions and operational modes are verified. Engineering data confirming basic functions are acquired and evaluated. The FT also includes, to the extent feasible, application software, mechanism activation, and in the instrument case, science data acquisition. All commands to be used in operations tests with the flight hardware are first tested using the VEST with brass boards, engineering models, or SI simulators to ensure that the commands are correct and safe for the flight hardware. During the entire series of functional tests, data is compared to specifications and to data from the vendor acceptance testing. These test results become the baseline against which future data, including on-orbit performance, are compared. In addition to the primary subsystem test, VEST develops a full-up system functional test that verifies both the primary and redundant subsystems. The System Functional Test is a test run on the ORU/ORI in the VEST to exercise all electrical functions performance of the flight hardware with the VEST ground system.

5.8 GROUND SYSTEM TEST

While located in the VEST Facility at GSFC, each ORI and ORU is included in a special operational exercise known as a Servicing Mission Ground Test (SMGT). The SMGTs are defined in detail in "The Servicing Mission 3 Operations Test Plan" SMR-3043. The SMGTs are executed from the STOCC and other appropriate HST operations support facilities. This test demonstrates compatibility between the HST ground and flight systems by validating STOCC real-time commanding, command loads, and telemetry processing. The SMGT utilizes all appropriate operations elements of the GSFC ground systems, facilities, and personnel. This testing also demonstrates the capability of the Ground System, flight software systems, Servicing Mission PDB, Servicing Mission PRD, scheduling, and commanding for ORI/ORU operations. The SMGT includes Servicing Mission operations that can be safely performed in the VEST environment.

5.9 SYSTEM LEVEL TESTs

Two system level tests are performed utilizing all the ORU and ORI replacement hardware. A Ground System Test is performed with all SM3 replacement hardware integrated into the VEST Facility in operational modes that verify proper operation of all ORIs/ORUs with all other HST subsystems. The SMGT is run from the STOCC using the SM3 Command Plan, as limited by ground constraints, starting at the pre-grapple point in the mission timeline and ending at vehicle release. This process validates the Mission Command Plan, command and telemetry functions, and Sthe Ground System while providing training for Operations personnel.

The second system test is a compatibility test that is run with all the replacement hardware installed in VEST. The test is structured to exercise the various modes of operation of the new hardware and verify its compatibility with the HST system as a whole in the post-servicing mission configuration. This test will be run with the HST486 computer and not the DF-224.

There are two tests that occur during the hardware development phases that I&T participate. The first is a TDRSS Compatibility test for the flight SSAT.

The second, is ASCS environment test program. Due to limitations of the ASCS/NCS operation at ambient temperature, I&T will participate in the thermal vacuum testing of the ASCS/NCS. Operation sequence will be included as part of this testing.

5.10 GSFC INTEGRATION AND TEST CLOSE-OUT ACTIVITIES

After successful completion of I&T activities, the flight hardware and associated GSE are packed and shipped to the launch site at KSC. A Pre-Ship Review is held at GSFC prior to shipment of the payload to verify the readiness of all payload systems. As part of this review, a summary verification history of the payload is presented, including if applicable, identification of anomalies and their dispositions, waivers, and any open actions from previous reviews. The review also includes a summary and status of safety requirements and compliance. Status of all mission documentation is reviewed.

5.11 MISSION OPERATION SUPPORT

The I&T Teams also support the Launch Control Team at KSC during simulations and launch operations and the Operations Control Center Team during the Servicing Mission Orbital Verification (SMOV) mission phases. It is anticipated that one or more members of the I&T Team will be assigned to the Shuttle Mission Control Center at the Johnson Space Center during launch and early orbi-tal operations. Members of the team are also expected to be present in the STOCC during the Shuttle mission period. They will be available if needed for support during the Servicing Mission Observatory Verification Period.

5.12 POST-MISSION DE-INTEGRATION

After the SM3 returned flight hardware arrives at GSFC, the hardware is removed from the shipping containers/carriers and contamination inspections performed. The returned hardware is turned over to the respective hardware managers for further evaluation and disposition.

6. KSC PAYLOAD ACTIVITY

6.1 LAUNCH SITE SUPPORT PLAN

Payload activity at KSC consists of off-line processes and closeout operations managed by the GSFC payload organization and on-line processes that KSC manages with the support from GSFC payload personnel. Activities which require KSC support are defined in Annex 8 - Launch Site Support Plan. The Launch Site Integration Plan (LSIP) is the detailed plan for the implementation of the launch integration process.

6.2 PAYLOAD PROCESSING FACILITY ACTIVITIES

All payload elements are sent to the designated Payload Processing Facility (PPF) for SM3 offline SSE operations. The KSC PPF will be either the PHSF or the VPF depending on the availability of facilities. The SSE and ORUs are sent to the KSC PPF. Cape Canaveral Air Force Station Building AE is designated as the PPF for initial SI post-shipment I&T activities. At Building AE, the SI are removed from the shipping containers, checked for contamination, inspected for shipment damage, and prepared for post-shipment functional testing by project and contractor personnel. After testing, the SI is prepared for transport to the KSC PPF for integration into their respective SIPEs. During all SI integration and test operations prior to SIPE installation, the SIs are bagged and purged with GN2.

SSE EGSE and MGSE arrive at the PPF in advance of the SSE elements to allow for cleaning, staging, set-up, and checkout. The SSE is unloaded from the shipping containers and undergoes contamination inspection, receiving inspection, and staging in the appropriate MGSE fixture. Functional tests are performed for individual SSE elements prior to an integrated test between the ORUC and FSS. Following the completion of SSE testing, the facility, carriers, and SIPEs are prepared for SI/SIPE integration. Close-out operations are performed in preparation for canister installation. The SSE is transferred to the canister and transported to the Canister Rotation Facility (CRF) for rotation to the vertical position. If a CITE test is to be performed the canister is transported to the VPF, otherwise the canister is transported to the pad.

6.3 ON-LINE VERTICAL PROCESSING FACILITY OPERATIONS

The SSE is transferred from the vertically oriented canister into the Vertical Payload Handling Device (VPHD). Once hard down in the VPHD hooks, electrical mates are made. Following completion of electrical mates, the Cargo Integration Test Equipment (CITE IVT) is performed to verify requirements documented in PIP Annex 9. After completion of the IVT, an ETE test is performed that includes JSC, GSFC STOCC, and supporting ancillary facilities. VPF closeout operations for the SSE commence after successful completion of the IVT and ETE test. The SSE is then transferred back into the canister for transport to the launch pad.

6.4 PAYLOAD CHANGEOUT ROOM PROCESSING

Upon arrival at the launch pad, the payload is transferred to the Payload Ground Handling Mechanism (PGHM). Minimal payload operations are planned prior to installation of the Payload into the Orbiter.

6.5 ORBITER INTEGRATION

When the Payload is ready on the PGHM, its -Z axis protective bagging is removed and the PGHM transfers the payload into the Orbiter payload bay. The remaining +Z protective bagging is removed after installation into the payload bay. Mechanical and electrical interfaces with the Orbiter are mated and an Orbiter IVT is performed followed by an ETE test. Requirements for these tests are documented in PIP Annex 9. Upon completion of these tests, payload GSE is removed and payload bay final closeout activities are performed.

6.6 POST LANDING OPERATIONS

The nominal end of mission landing is scheduled for KSC. A payload bay conditioned dry-air purge is initiated within 45 minutes of landing. The Orbiter is towed to the OPF for post-mission de-integration. Access to the payload bay is planned to occur within 72 hours of touchdown. The payload is removed from the payload bay and transported in the payload canister to the PPF for de-integration and other off-line operations. For landing sites other than KSC, the Orbiter is returned aboard the Shuttle Carrier Aircraft (SCA). Normally, access to the payload bay is not provided until the Orbiter is in the OPF.

6.7 POST MISSION PAYLOAD DE-INTEGRATION

The SSE is removed from the payload canister upon arrival at the KSC PPF. The returned ORIs are de-integrated from the carriers prior to shipment to GSFC. No post-mission testing is planned at KSC unless dictated by an in-flight anomaly. The remaining MGSE and EGSE are shipped back overland to GSFC via truck.

7. SHUTTLE PHASE ON-ORBIT TESTING

On-orbit testing consists of two phases. The first phase is the period that HST is berthed to Shuttle (or in near proximity). The second phase, called the Servicing Mission Orbital Verification commences when the Shuttle maneuvers away from HST to terminate the Servicing Mission. This section addresses the general test requirements for the first phase of on-orbit testing. This testing consists of an Aliveness Test (AT) and a Functional Test (FT) for each ORI or ORU being replaced during the mission or any interface disturbed. This testing is integrated into the servicing Mission Command Plan and executed by the HST STOCC.

7.1 ALIVENESS TESTING

The requirement of the AT is to verify that each flight hardware electrical interface is successfully mated to the appropriate HST harness. This test attempts to verify all connectors are properly mated by sending specific commands and observing appropriate telemetry responses. This test is performed only on the primary side of the replacement ORI/ORU. The AT is limited to 10 minutes and is accomplished prior the worksite being closed out by the EVA astronaut. The AT is limited to 10 minutes to allow time for the EVA crew to perform contingency tasks, if needed (e.g., reseat connector, examine pins), during the same EVA day and avoid impacting subsequent EVA tasks.

7.2 FUNCTIONAL TESTING

The requirement for the FT is to verify that the mission critical functions of the ORI/ORU have survived the launch environment and perform properly on orbit. If a mission critical function fails then the decision will be made to remove the new ORI/ORU and reinstall the original hardware. The FT is performed only on the ORI/ORU primary side. The FT is usually performed as soon as is practical after the AT. The time goal is to complete the FT in approximately one hour.

8. SSE TEST PROGRAM

8.1 SSE INTEGRATION AND TEST FLOW

The SSE System test program is defined in this section. Standard NASA/GSFC policies and guidelines are observed for all operations except where noted. The SSE test program imposes all standard administrative controls for readiness reviews, documentation, and performance verification requirements. Level III requirements are derived from STR-81.

8.2 ENVIRONMENTAL CONTROLS

Standard GSFC guidelines for an ambient environment are imposed as stated in Section 3.3 of this document.

8.3 CONTAMINATION CONTROL

The SSE is double-bagged prior to shipment. A 100k clean room at GSFC is required for the SSE external surfaces and 10k clean room for the SIPEs when the lids are opened. All other contamination control requirements are imposed as stated in Section 3.4 of this document.

8.4 SAFETY

All SSE mission critical hardware meets the standard ground safety requirements as stated in Section 3.5 of this document. Slings, lifting fixtures, and facilities used to lift flight hardware must be certified for use prior to actual lifting by quality assurance and safety. The NICMOS Volume Simulator and

ACS Volume Simulator are to be used for handling training and initial fit checks.

8.5 SSE GROUND SUPPORT EQUIPMENT

The following MGSE support I&T activities at GSFC and KSC as noted:

• FSS/HOST trunion lift blocks*	GSFC and KSC
• MULE/HOST handling dolly	GSFC and KSC
• MULE outriggers	GSFC and KSC
• FSS/ORUC lift sling*	GSFC and KSC
• FSS scaffolding	GSFC and KSC
• FSS outrigger	GSFC and KSC
• FSS outrigger sling*	GSFC and KSC
• ORUC shelf lift sling	GSFC and KSC
• ASIPE low-boy dolly	GSFC
• RSIPE cover lift sling	GSFC
• ASIPE work table (ORUC)	GSFC
• ASIPE lift sling	GSFC
• ORUC scaffolding	GSFC and KSC
• RAC trunion lift blocks	GSFC and KSC
• RAC lift sling	GSFC and KSC
• RAC handling dolly	GSFC and KSC
• RAC scaffolding	GSFC and KSC
• OPE lift sling	GSFC and KSC SCN 001
• MULE scaffolding	GSFC and KSC
• MULE handling dolly	GSFC and KSC

The following EGSE support I&T activities at GSFC and KSC as noted:

• FSS controller rack	GSFC and KSC
• FSS HST/ORUC simulator	GSFC and KSC
• FSS STS simulator	GSFC and KSC
• FSS PRLA simulator	GSFC and KSC
• MULE/HOST controller rack	GSFC and KSC
• ORUC controller rack	GSFC and KSC

Also used for MULE

8.6 PHOTOGRAPHIC/VIDEO SUPPORT

Standard photo requirements are imposed as stated in Section 3.6 of this document.

8.7 MECHANICAL VERIFICATIONS

This section presents information pertinent to the various mechanical aspects of the SSE including fit test of the ORI/ORUs into their respective protective enclosures.

8.7.1 Flight Support System

The FSS shall be available for EVA verification activity and crew familiarization. Crew familiarization shall also include remote operation of mechanisms. The FSS shall be prepared for shipment to KSC upon completion of the I&T activities.

8.7.2 Orbital Replacement Unit Carrier

The ORUC shall be available for the following System I&T activity:

- ORU to ASIPE shelf fit checks
- FGS/RBM to RSIPE fit checks
- ORU to OPE fit checks
- EVA Verification
- Crew Familiarization

The ORUC shall be prepared for shipment to KSC upon completion of the I&T activities.

8.7.3 Rigid Array Carrier

The RAC shall be available to support the following System I&T activities:

- SA2 & SA3 fit checks
- ORU fit checks
- EVA Verification
- Crew familiarization

The RAC with the two SA3 Wing assemblies installed shall be prepared for shipment to KSC upon completion of the I&T activities.

8.7.4 MULE Carrier

The MULE shall be available to support the following System I&T activities:

- ASCS/NCS Radiator fit checks
- ORU-to-MULE fit checks
- EVA Verification
- Crew familiarization

8.7.5 Second Axial Carrier

The SAC shall be available to support the following System I&T activities: SCN 001

- ACS to ASIPE fit checks
- ORU-to-OPE fit checks
- EVA Verification
- Crew familiarization

8.8 FSS/VEST COMPATIBILITY TEST

The FSS/VEST Compatibility Test shall consist of a nominal mission run followed by contingency tests. The nominal run shall simulate a nominal HST mission. The Servicing Mission Integrated Timeline (SMIT procedures for HST retrieval and deployment power transfers shall be verified during the nominal run. Contingency tests shall simulate possible anomalies such as power transients with HST batteries at a low-state of charge, loss of FSS sync circuits, and loss of up to four FSS Direct

Power Converters (DPCs. The contingency tests also characterize the FSS voltage characteristic under low-load conditions.

8.8.1 Nominal Mission Test

The following scenario is exercised during the nominal mission test:

- VEST internal power shall be in the partially discharged state (55 Amp/Hour per HST battery simulation) to represent the state of charge in the system following rendezvous from the power-negative attitude.
- VEST internal power shall simulate a HST six battery configuration via the VEST Battery Simulator (VBS at the level of 35A minimum. This 35A level represents the HST load after the FHST, FGSs, SADE and non-essential heater groups are deactivated.
- The FSS shall then be connected to VEST via the umbilical interface.
- The FSS shall apply external main and essential power to VEST
  via either the Standard Switch panel (SSP or the Astronaut Control Panel (ACP) leaving the internal main bus on (HST batteries on-line) and the internal essential bus off.
- VEST shall then simulate battery charging by the solar arrays and the various dynamic loads expected during the mission including SI and other ORU changeouts and recovery from non-essential load reduction.
- The FSS shall power on VEST internal essential power and remove external main and essential power from VEST and then FSS shall power down.

Throughout the test, VEST shall capture any data dropouts and archive the data. The DMS shall be monitored to verify that no data dropouts occur during transition sequences between VEST internal essential power to Orbiter (FSS) external power support, battery charging, and Orbiter to VEST internal power. Power transient signatures shall also be captured and analyzed.

8.8.2 Contingency Tests

There shall be four contingency tests:

- The VEST shall be under low voltage internal power simulating the HST batteries at low state-of-charge. The FSS shall then be physically connected and powered on. Transients shall be recorded.
- The VEST shall be powered by the FSS. The FSS shall disconnect synchronization circuitry in the FSS Power Conditioning Units (PCU) and record transients.
- The VEST shall be powered by the FSS. FSS shall disable up to four FSS DPCs (voltage shall be monitored so as not to drop below 26V at the VEST main bus). Transients shall be recorded.
- The VEST shall be powered by the FSS. The VEST shall reduce the load to 25 amps and verify that VEST main bus voltage

  does not exceed acceptable levels. The FSS shall terminate external power, leaving VEST internal main and external power on, and verify that VEST essential bus voltage does not exceed acceptable levels. (All voltages specified in ST-ICD-10, Paragraph 7.14 (IRN-43) should ultimately be verified.)

Throughout the test, VEST shall capture any data dropouts and archive the data. The DMS shall be monitored to verify that no data dropouts occur during transition sequences between VEST internal essential power to Orbiter (FSS) external power support, battery charging, and Orbiter to VEST internal power. Power transient signatures shall also be captured and analyzed.

8.8.3 EMI Tests

EMI measurements shall be taken during the FSS/VEST testing. These activities shall not affect the test scenario. Refer to the EMI Test Plan (LMSC/P016262A) for test setup and test description.

9. ACS TEST PROGRAM

9.1 ACS INTEGRATION AND TEST FLOW

The SI-unique test program for ACS is defined in this section. Standard NASA/GSFC policies and guidelines are observed for all operations except where noted. The SI test program imposes all standard administrative controls for readiness reviews, documentation, and performance verification requirements. Level III requirements are derived from STR-81. The preferred test flow for the ACS at GSFC is illustrated in Figure 9-1.

9.2 ENVIRONMENTAL CONTROLS

The SI test program imposes standard ambient environment requirements as stated in Section 3.3 of this document.

9.3 CONTAMINATION CONTROL

ACS is bagged prior to shipment. A class 10k clean room environment is required for receiving and inspection. The instrument remains bagged or in a purge through the aperture at all times except when the bag is opened or the purge removed for a specific integration or test activity. The 10k cleanliness level shall be maintained at all times up to and including launch.

The maximum allowable interruption to the purge is one (1) hour in any 24-hour period, except for interruptions specified in an approved test procedure. If ACS is not in a purge tent or bag, a purge line is fitted at the aperture to maintain purge. The

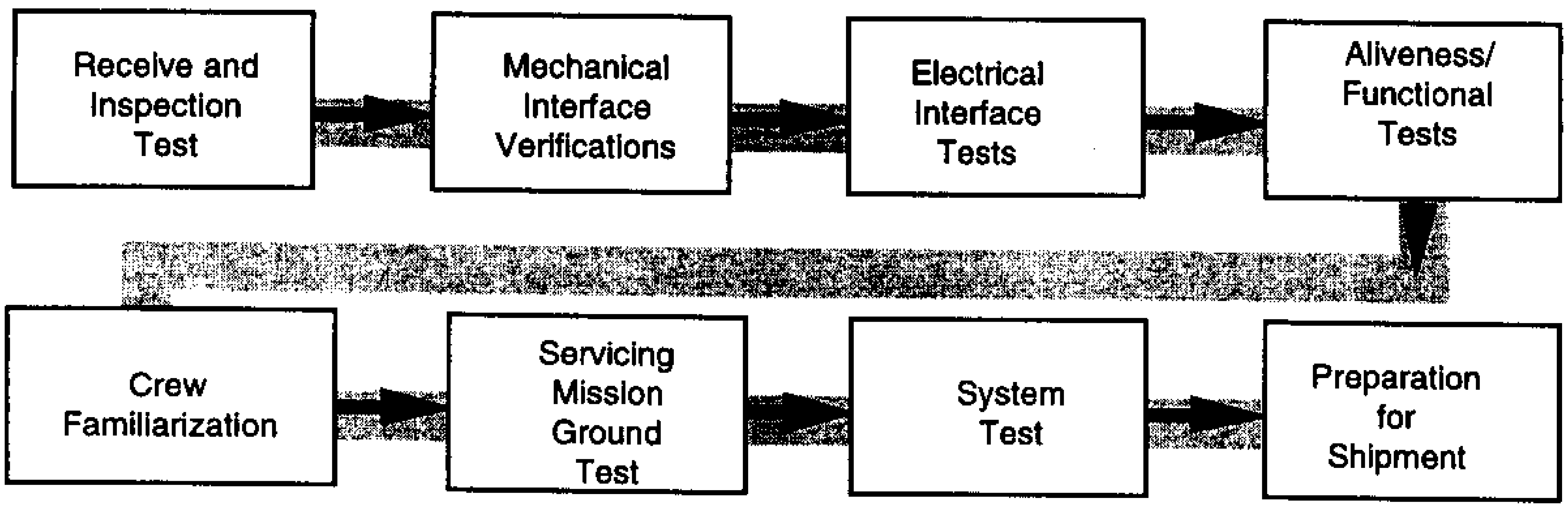

Figure 9-1. ACS Test Flow at GSFC

Purge is maintained from integration into the SIPE Until launch at KSC. The SI test program imposes the purging purity requirements defined in SPS-2703. All other contamination control requirements are imposed as stated in Section 3.4 of this document.

9.4 SAFETY

The construction of the SI imposes a constraint on the handling methods which can be used, namely that the SI cannot be placed on the side faces in any position, even if contact is restricted to the end plates only.

The GSFC ACS Volume Simulator is used for handling training and initial fit checks prior to the checks with ACS. Slings, lifting fixtures, and facilities used to lift flight hardware are certified by quality assurance and safety for use prior to actual lifting. All ACS mission critical hardware meet the standard ground safety requirements as stated in Section 3.5 of this document.

A ground strap is required between facility ground and the ACS at all times. Whenever practical, connector savers shall be used. All mating and demating is done with all four FOC/ACS PDU relays open and the instrument grounded.

9.5 ACS GROUND SUPPORT EQUIPMENT

The MGSE and EGSE listed in the following subsections are used in support of I&T activities.

9.5.1 ACS Mechanical Ground Support Equipment

A wheel equipped handling frame or dolly is provided by the SI contractor. The dolly supports the SI by means of "end plates" bolted to the SI +V1 and -V1 surfaces which provide a trunnion interface to the dolly frame. While supported in the dolly, the SI can be rotated to any position about its principal axis to facilitate access and the attachments of slings and other MGSE. A dedicated four point handling sling designed to lift ACS in its horizontal position is provided by the SI contractor. This sling is used to remove ACS from its dolly for installation into the SIPE and other handling as required.

The GSFC provided GN2 purge cart is used to support the ACS during transportation and processing at GSFC and KSC.

9.5.2 ACS Electrical Ground Support Equipment

SITS is the EGSE used for post-ship testing of ACS.

9.6 HANDLING, TRANSPORTATION, AND STORAGE

ACS is stored in the shipping container or bagged, with purge gas flowing.

9.7 RECEIVING AND INSPECTION

The flight hardware and supporting GSE is unpacked and undergoes R&I. The I&T Team, consisting of mechanical engineers, hardware representatives, and flight assurance representatives, perform the R&I in accordance with approved procedures These procedures, as a minimum, identify unpacking requirements, handling constraints, mechanical tasks, responsibility, facilities, GSE, and safety constraints. Standard GSFC guidelines for an R&I are imposed as stated in Section 5.2.

9.8 POST-SHIPMENT TEST

The objective of this test is to verify that ACS performs properly after arrival at GSFC and prior to VEST Facility integration and test. The test consists of a repeat of the factory aliveness, functional, and system tests using the ACS SITS.

9.9 MECHANICAL VERIFICATIONS

This section presents information pertinent to the various mechanical verification aspects of the instrument (refer to Section 5.3).

9.9.1 Volumetric Measurements

Prior to installation of the ACS into the ASAC or HFMS, critical mechanical envelope and attachment interfaces are verified. The ACS external envelope is verified per requirements in ST-ICD-02 prior to shipment to GSFC using procedures and equipment developed by GSFC. These interfaces include the three latch locations and orientations, the external envelope, and the guide block positions. If any modifications to the flight hardware are made after this envelope verification at the hardware developers, additional measurements are required at GSFC to ensure compatibility with the ORUC and HST (including the HFMS). The same procedures used to verify these envelopes at the hardware developer apply at GSFC.

9.9.2 ACS-to-SIPE Fit Test

The ACS arrives on the appropriate handling dolly. The instrument is moved into place and the ACS lifting sling attached. The hardware is then lifted by the crane/hydraset assembly and the dolly removed. The ASAC containing the Axial Scientific Instrument Protective Enclosure (ASIPE) will have been leveled and readied for installation of the instrument. The instrument is moved over the ASIPE, the hardware lowered and installed in the ASIPE, and the lifting fixture removed. The EVA "L" handle is installed on the ACS hardpoints to verify envelope clearance. Note that the "L" handle must be removed and the appropriate lifting fixture reinstalled prior to de-integration.

9.9.3 ACS-to-HFMS Fit Test

The ACS is placed into the HFMS by the SIFIG. These tests verify latch positions, instrument envelope, guide block positions, and the electrical connector interfaces.

9.9.4 EVA Crew Aid/Tool Check

All crew aid and tool testing not performed by the vendor shall be accomplished in the clean room with the SI in the HFMS, ORUC, ASIPE, or on the handling dolly. The EVA interfaces are fit-checked and, if practical, functionally tested. The flight power ratchet tool and multisetting torque limiter (MTL) are used to turn the latches in the automatic and manual modes.

9.10 ELECTRICAL INTERFACE TESTS

The EICIT and IVT (refer to Section 5.5) are executed with Break Out Boxes (BOBs) and Break Out Cables (BOCs) installed to isolate ACS from the associated test articles and facilitate point-to-point measurements. The EICIT is run first followed by the IVT. The BOBs and BOCs are removed after successful completion of the IVT.

9.10.1 Electrical Interface Continuity and Isolation Test

The EICIT verifies that the continuity, impedance, and isolation characteristics of all ground, power bus, and input/output signal lines between the ACS and VEST comply with the specifications detailed in ST-ICD-08 and ST-ICD-02E.

9.10.2 Interface Verification Test

The IVT verifies the initial power-on and control signal characteristics of the interface between the ACS, VEST test harness, and the associated VEST EGSE.

9.10.2.1 Initial Power-On Checks. These checks are executed with only the power and ground connections jumpered to pass through the BOBs. Both the primary and redundant side of ACS shall be checked. These checks measure and record the initial power-on states of ACS including:

- In-Rush Current is measured using appropriate test instrumentation at the BOB connected closest to the ACS input power connector(s) upon powering-on the system. The power-on sequence energizes Remote Interface Units (RIUs first, verifies relay configuration, energizes hold bus, and finally, if safe and practical, energizes the operate bus.
- Steady State Power Levels are measured using appropriate test instrumentation at the same point as the In-Rush Current Checks are made to measure the quiescent power state of the instrument.
- Stray Voltage Checks are made on the ACS connectors.

9.10.2.2 Control Signal Verification These checks are made with all ACS power, ground, and signal I/O connections jumpered to pass through the BOBs. This test verifies the functionality of all lines in the interface and the assignments of the ACS input/output drivers and/or receiver lines.

The telemetry data transfer function is tested to demonstrate that the input/output drivers and/or receivers are correctly assigned and match up to one another. This test verifies the control signals to ACS by activating specified functions on and off to ensure the correct response. The telemetry data lines are checked to verify they are within specifications for ACS.

9.11 ALIVENESS TEST

The AT is a short power-on test to perform health and status checks (refer to Section 5.6). The AT starts with a replica of the planned Shuttle Phase (on-orbit) AT. The AT verifies electrical connections in all four connectors that comprise the power, engineering telemetry, and science data paths. Telemetry is monitored to verify that the power and thermal values (if available) are within acceptable ranges. At the end of the AT, ACS is left in the thermal safe mode. From the thermal safe mode, ACS can be sequenced to the mode of operation required for the next test(s). The outline of the basic AT is:

- Apply RIU-A and RIU-B power and verify RIU-B conditioned analog telemetry
- Transition to RIU-A and verify Side-1 relay configuration
- Apply Side-1 and Side-2 instrument power
- Enable NSSC-I flight software
- Boot Control Section (CS)
- Enable science interface and dump memory
- Disable CSCOMM and macro Application Processor (AP
- Open MEB OPERATE relay

The ACS Aliveness Test consists of the following tests:

- <u>LAUNCH (or OFF) mode to SAFE mode transition</u> - this transition is contained in the command procedure JLCSAF (or JOFFSAF). Power is applied to the ACS RIUs. The RIU on the selected side is commanded to Standby 2 mode and the alternate RIU is commanded to Standby 1. The internal ACS relays are commanded to their SAFE mode configuration. Finally, instrument power is applied to both sides of ACS.

- SAFE mode to HOLD mode transition - This transition is contained in the command procedure JSAFHLD. The RIU is commanded to standby 2 mode on the selected side, then the internal ACS relays are commanded to their HOLD mode configuration. The WFC and HRC TECs may optionally be enabled to begin cooling the CCD detectors. The NSSC-1 ACS Safing application processor is initialized and enabled, and finally the standard ACS science data formats are loaded into the CU/SDF.

- HOLD mode to BOOT mode transition - This transition is contained in the command procedure JHLDBOOT. The ACS Control Section is powered and the BOOT FSW image begins running. Nominal BOOT mode functions are enabled. The NSSC1 CSCOMM and Macro application processors are initialized and enabled.

- Science Data Transfer Test - The JALIVESD command procedure is used to transfer 1 line of ACS science data (memory dump) from ACS to the NSSC1, not to the HST Science Tape Recorder. The data is verified using memory monitors in the NSSC1 as well as ACS to verify data "sent and received". The JALIVESD command procedure performs all necessary setup and dump commanding as well as dump verification. If the procedure completes normally, then the transfer was successful.

9.12 SAFING AND RECOVERY TEST

This test, a subset of the BASD tests, verifies the operation of the safing processor. Successful completion of the following routine demonstrates the capability of the instrument to communicate with the NSSC-I:

- Submit NSSC-I Executive Status Buffer message and continue
- Submit requests to Suspend Instrument (MEB off, all mechanical activity off, stored commands disabled)
- Submit requests to Safe Instrument (MEB off, stored commands disabled)

PSTOL and CCL and stored command procedures for the instrument recovery after safing will be fully tested with ACS and VEST.

9.13 FUNCTIONAL TEST

The FT is a replica of the functional test planned for the Shuttle Phase (refer to Section 5.7). The FT verifies that major elements within ACS are functioning correctly. It is not the purpose of this test to determine the detailed functional operations of all items, but rather that subsystems operate and that major instrument functional states (e.g., hold power, boot CS, enable science interface, and dump memory) operate as designed. Additionally, critical mechanism operations and detectors are verified to the extent possible.

The BASD test results shall be used as the criteria to evaluate the VEST Functional Test results. There are presently no limitations within the VEST system to prevent performance of these tests; however, ACS constraints and restrictions may prevent full implementation of the BASD procedures.

9.14 SYSTEM FUNCTIONAL TEST

The System Functional Test exercises the instrument functions by running many of the operational modes utilizing as many command structures as possible. The test is performed using stored commands as specified in a SMS delivered from the ST ScI to verify PLCP command blocks and tables structures built for commanding the instrument. The tables are the basic structure for the command macros that will be sent to the instrument.

9.15 SOFTWARE

ACS-unique software validated during I&T activities consists of:

- NSSC-I flight software
- CS flight software
- MAMA Interface Electronics flight software
- MAMA Control Electronics flight software

9.16 CREW FAMILIARIZATION

Refer to Section 5.4.

9.17 GROUND SYSTEM TEST

ACS shall be used for SMGT-ACS (refer to Section 5.8). This SMGT is executed in conjunction with the STOCC and other appropriate HST operations support facilities. This test demonstrates compatibility between the HST ground and flight systems by validating the STOCC operations real-time commanding, command loads, and telemetry processing and provides an opportunity to debug procedures and software. The SMGT utilizes all appropriate operations elements of the GSFC ground systems, facilities, and personnel. This testing also demonstrates the capability of the Ground System, flight software systems, Servicing Mission PDB, scheduling, and commanding for ACS operations. The SMGT includes Servicing Mission operations that can be safely performed in the VEST environment.

9.18 SYSTEM LEVEL TEST

ACS shall be used to support the system level testing. (refer to Section 5.9).

9.19 PREPARATION FOR SHIPMENT

At the completion of GSFC I&T activities ACS is tested with the vendor GSE to establish a pre-shipment baseline. The SI is then placed in the transporter for shipment to KSC in an Air-Ride Van.

10. FGS/RBM TEST PROGRAM

10.1 FGS/RBM INTEGRATION AND TEST FLOW

The FGS/RBM-unique test program is defined in this section. Standard NASA/GSFC policies and guidelines are observed for all operations except where noted. The FGS/RBM test program imposes all standard administrative controls for readiness reviews, documentation, and performance verification requirements. Level III requirements are derived from STR-81. The test flow for the FGS/RBM at GSFC is illustrated in Figure 10-1.

10.2 ENVIRONMENTAL CONTROLS

Standard GSFC guidelines for an ambient environment will be followed.

10.3 CONTAMINATION CONTROL

A Class 100k environment will be maintained at all times up to and including launch.

10.4 SAFETY

Ground straps are attached between facility ground and the FGS/RBM enclosure at all times when out of its shipping container. Whenever practical, connector savers shall be used. All mating and demating of VEST electrical cabling is done with all PDU/FGS/RBM relays open and the FGS/RBM grounded. All FGS/RBM mission critical hardware shall meet the ground safety requirements of KHB 1700.7B.

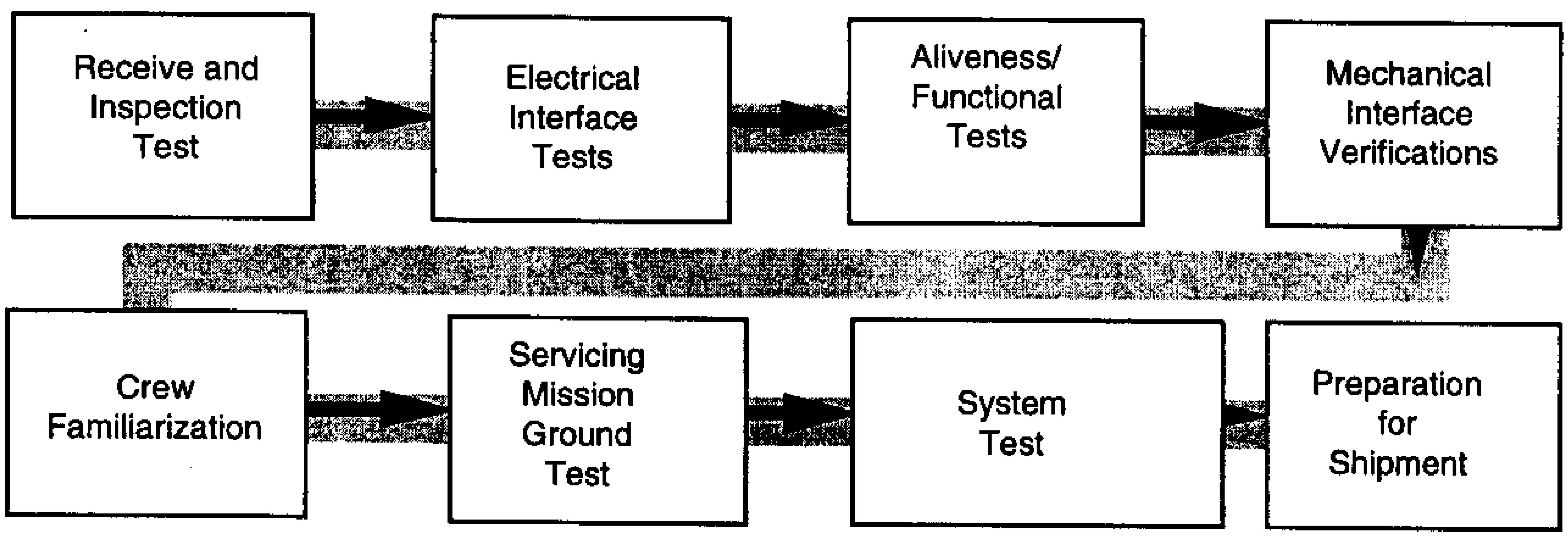

Figure 10-1. FGS/RBM Test Flow at GSFC

10.5 FGS/RBM MECHANICAL GROUND SUPPORT EQUIPMENT

The MGSE and EGSE listed in the following subsections are used in support of I&T activities.

10.5.1 FGS/RBM Mechanical Ground Support Equipment

The Mechanical Ground Support Equipment consists of the various pieces of GSE required to transport, handle and rotate the FGS/RBM. This equipment is listed:

RBM Transporter
Gravity Release fixture
RBM Adapter Plate
Horizontal Handling Sling
WF/PC Vertical Handling Sling

10.5.2 FGS/RBM Electrical Ground Support Equipment

The Star Simulator Test Set (SSTS) will be transported to GFSC, set up and calibrated to provide a star source for powered alignment checks.

10.6 RECEIVING AND INSPECTION

The FGS/RBM is shipped to GSFC after completing acceptance testing at the vendor location. The shipping containers are inspected for identification and damage. The FGS/RBM is moved into the Clean Room and inspected for identification, damage, and cleanliness.

10.7 MECHANICAL VERIFICATION

This section presents information pertinent to the various mechanical aspects of the FGS/RBM.

10.7.1 Volumetric Measurements

Prior to installation of the FGS/RBM into the ORUC FSIPE or HFMS, critical mechanical envelope and attachment interfaces are verified. These interfaces include the four latch location and orientations, the external envelope, and the guide block positions.

10.7.2 FGS/RBM Fit Check into HFMS FGS Bay 3

The FGS/RBM is mechanically integrated into and de-integrated from the HFMS FGS Bay 3. An end-to-end sequence, including opening Bay 3 doors, disconnecting the harness, removing and installing the FGS/RBM is verified. The FGS/RBM shall be in its flight configuration.

10.7.3 FGS/RBM Mounting Studs to CAT Fit Check

A fit check is made with the appropriate CATs to each flight FGS/RBM bolt head.

10.7.4 Flight FGS/RBM to Pickoff Mirror Cover Fit Test

The Flight Pick off mirror cover will be fitcheck with the RBM.

10.7.5 Flight FGS/RBM to FSIPE and OPE Fit Test

The FGS/RBM is mechanically integrated into and de-integrated from the flight FSIPE. Procedures were developed and validated during SM2. The Flight spare OCE EK harness will be fit check in the appropriate OPE.

10.8 ELECTRICAL INTERFACE TESTS

The EICIT and IVT are executed with BOBs and BOCs installed to isolate the FGS/RBM from the associated test articles and facilitate point-to-point measurements. The EICIT is run first followed by the IVT. These interface tests verify that the FGS/RBM meets requirements.

10.9 ALIVENESS TEST

The AT is initiated after the EICIT and IVT are success-fully completed and the BOBs and BOCs are removed. The AT is a short test in which FGS/RBM with the flight spare OCE EK harness is powered-on for health and status checks. The AT starts with a planned shuttle phase (on-orbit) AT. The AT verifies electrical connections exist in all connectors except J-6 which is the output of the PMTs. The on-orbit AT provides a quick-look on the A side of the FGS/RBM. The VEST AT will provide a check through both A and B side command paths. The AT will be run with both a DF-224 and a HST486 computer installed in VEST.

10.10 FUNCTIONAL TESTS

The FT consists of sending various high level discrete commands to FGS/RBM-2 and observing appropriate telemetry response. The FT will be run with both a DF-224 and a HST486 computer in-stalled in VEST.

A VEST System Functional Test demonstrates the functionality of both A- and B- sides of the FGS/RBM-2.

10.11 CREW FAMILIARIZATION

Refer to Section 5.4.

10.12 SERVICING MISSION GROUND TEST

SMGT-FGS2 (refer to Section 5.8) consists of a series of tests comprised of an AT and FT except that the commands come from STOCC instead of the VEST.

10.13 SYSTEM TEST

The flight FGS/RBM and flight spare OCE EK harness shall be installed in the VEST and used to support the system level testing (refer to Section 5.9).

10.14 PREPARATION FOR SHIPMENT TO LAUNCH SITE

At the completion of GSFC I&T activities FGS/RBM is tested with the VEST in the SSTS to establish a pre-shipment base-line. The FGS/RBM is then placed in the transporter for shipment to KSC in an Air-Ride Van. The OCE EK harness is installed in the OPE in flight configuration.

11. HST 486 COMPUTER TEST PROGRAM

11.1 HST 486 COMPUTER INTEGRATION AND TEST FLOW

The HST 486 Computer-unique test program is defined in this section. Standard NASA/GSFC policies and guidelines are observed for all operations except where noted. The HST 486 Computer test program imposes all standard administrative controls for readiness reviews, documentation, and performance verification requirements. Level III requirements are derived from STR-81. The test flow for the HST 486 Computer at GSFC is illustrated in Figure 11-1.

11.2 ENVIRONMENTAL CONTROLS

Standard GSFC guidelines for an ambient environment will be followed.

11.3 CONTAMINATION CONTROL

A Class 100k environment will be maintained at all times up to and including launch.

11.4 SAFETY

Ground straps are attached between facility ground and the HST 486 enclosure at all times when out of its shipping container. Whenever practical, connector savers shall be used. All mating and demating of VEST electrical cabling is done with all PDU/HST 486 Computer relays open and the HST 486 Computer grounded. All

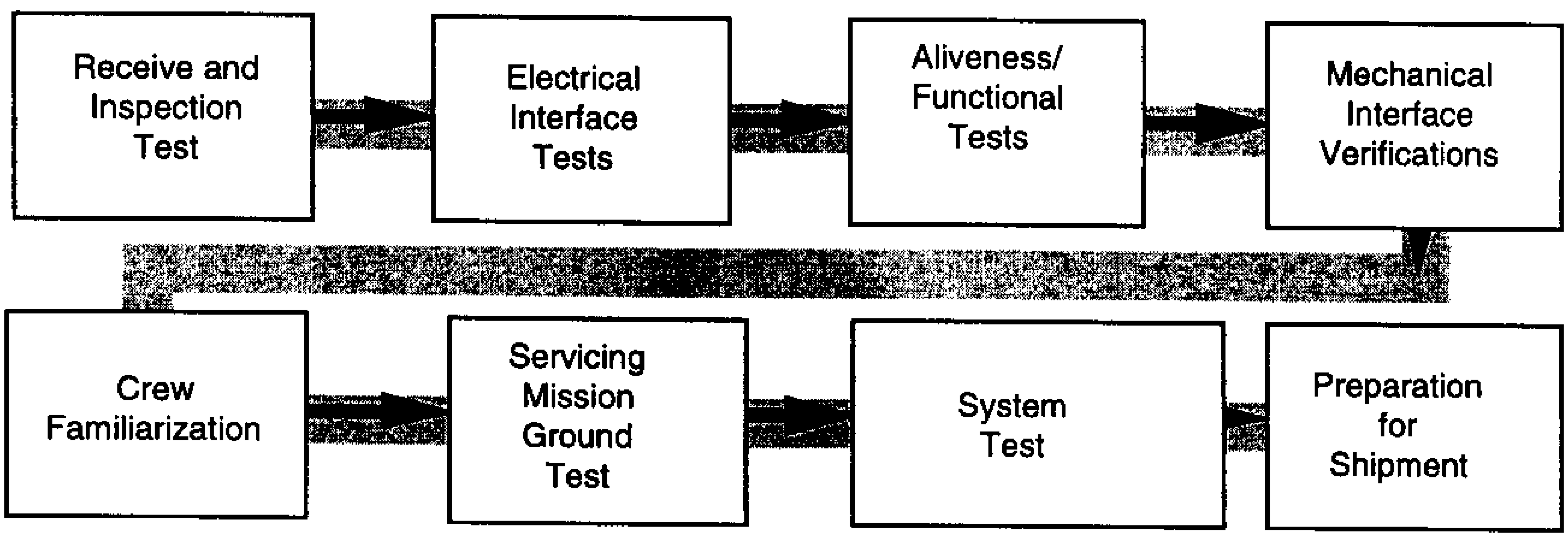

Figure 11-1. HST 486 Test Flow at GSFC

HST 486 Computer mission critical hardware shall meet the ground safety requirements of KHB 1700.7B.

11.5 HST 486 COMPUTER MECHANICAL GROUND SUPPORT EQUIPMENT

No special MGSE is used.

11.6 RECEIVING AND INSPECTION

The HST 486 Computer is shipped to GSFC after completing acceptance testing at the vendor location. The shipping containers are inspected for identification and damage. The HST 486 Computer is moved into the High Top Clean Room and inspected for identification, damage, and cleanliness.

11.7 MECHANICAL VERIFICATION

This section presents information pertinent to the various mechanical aspects of the HST 486 Computer.

11.7.1 HST 486 Computer Fit Check into VEST SSM Bay 1

The HST 486 Computer is mechanically integrated into and deintegrated from the VEST SSM Bay 1. Procedures are developed and validated using the EM HST 486 Computer. An end-to-end sequence, including opening Bay 1 doors, disconnecting the harness, installation of gender changers, removing and installing the HST 486 Computer is verified. The HST 486 Computer shall be in its flight configuration with all jumper cables and adapter connectors installed.

11.7.2 HST 486 Computer Mounting Bolt to CAT Fit Check

A fit check is made with the appropriate CATs to each flight HST 486 Computer captive mounting bolt head.

11.7.3 Flight HST 486 Computer to OPE Fit Test

The HST 486 Computer with associated adapters is mechanically integrated into and de-integrated from the flight OPE. Procedures are developed and validated first using the EM HST 486 Computer.

11.8 ELECTRICAL INTERFACE TESTS

The EICIT and IVT are executed with BOBs and BOCs installed to isolate the HST 486 Computer from the associated test articles and facilitate point-to-point measurements. The EICIT is run first followed by the IVT. These interface tests verify that the HST 486 Computer meets requirements for the A- and B-Sides.

11.9 ALIVENESS TEST

The AT is initiated after the EICIT and IVT are successfully completed and the BOBs and BOCs are removed. The AT is a short test in which the HST 486 Computer is powered-on for health and status checks. The AT starts with a planned shuttle phase (on-orbit) AT. The AT verifies electrical connections exit in all connectors that handle power, telemetry and commands. The on-orbit AT provides a quick-look on the A side of the HST 486 Computer followed by a switch to B side for a more detailed check with commands and telemetry responses. The VEST AT will provide a detailed check of both A- and B-sides.

11.10 FUNCTIONAL TESTS

The FT consists of sending various high level discrete commands to the HST 486 Computer and observing appropriate telemetry response. The B-side is verified to be properly functioning.

A VEST System Functional Test demonstrates the functionality of every pin of both A- and B- sides of the HST 486 Computer. Table 11-1 shows the various configurations tested.

11.11 CREW FAMILIARIZATION

Refer to Section 5.4.

11.12 SERVICING MISSION GROUND TEST

SMGT-HST 486 (refer to Section 5.8) consists of a series of tests comprised of an AT and FT except that the commands come from STOCC instead of the VEST.

11.13 SYSTEM TEST

The flight HST 486 Computer, Y-Harness, and EVA adapters shall be installed in the VEST and used to support the system level testing (refer to Section 5.9).

11.14 PREPARATION FOR SHIPMENT TO LAUNCH SITE

The flight HST 486 Computer in final flight configuration shall be inspected, photographed, and placed in the OPE for transportation to KSC. The connector converters and Y harness shall be placed in the OPE for transportation to KSC.

Table 11-1. HST 486 Functional Configurations

CONFIG. #	1	2	3	4	5	6	7	8	9	10	11	12
WHAT IS ON	SIDE	SIDE	SIDE	SIDE	SIDE	SIDE	SIDE	SIDE	SIDE	SIDE	SIDE	SIDE
+28V PWR	A	A	A	A	A	A	A	A	A	B	B	B
+28V HTR	A	A	A	A	A	A	A	A	B	B	B	B
DMU CMD	A	A	A	A	A	A	B	B	B	B	B	B
DMU TIME.	A	A	A	A	A	A	A	A	A	B	B	B
PCM	1	1	1	2	2	2	3	3	3	1	2	3
CPM	1	2	3	1	2	3	1	2	3	1	2	3
EX DAT BUS	A	A	A	B	B	B	B	B	B	B	B	B
PCM THERM CPM THERM	A/B A/B	A/B A/B	A/B A/B	A/B A/B	A/B A/B	A/B A/B	A/B A/B	A/B A/B	A/B A/B	A/B A/B	A/B A/B	A/B A/B
ALIVENESS	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
FUNCTION.	Y				Y							Y
SAFE MODE	Y				Y							Y

12. SOLAR ARRAY 3/DIODE BOX

12.1 SOLAR ARRAY 3/DIODE BOX INTEGRATION AND TEST FLOW

The SA3-unique test program is defined in this section. Standard NASA/GSFC policies and guidelines are observed for all operations except where noted. The SA3 and diode boxes test program imposes all standard administrative controls for readiness reviews, documentation, and performance verification requirements. Level III requirements are derived from STR-81. The test flow for the SA3 at GSFC is illustrated in Figure 12-1.

12.2 ENVIRONMENTAL CONTROLS

Standard GSFC guidelines for an ambient environment will be followed.

12.3 CONTAMINATION CONTROL

A Class 100k environment will be maintained at all times up to and including launch.

12.4 SAFETY

Ground straps are attached between facility ground and the SA3 enclosure at all times when out of its shipping container. Whenever practical, connector savers shall be used. All SA3 mission critical hardware shall meet the ground safety requirements of KHB 1700.7B.

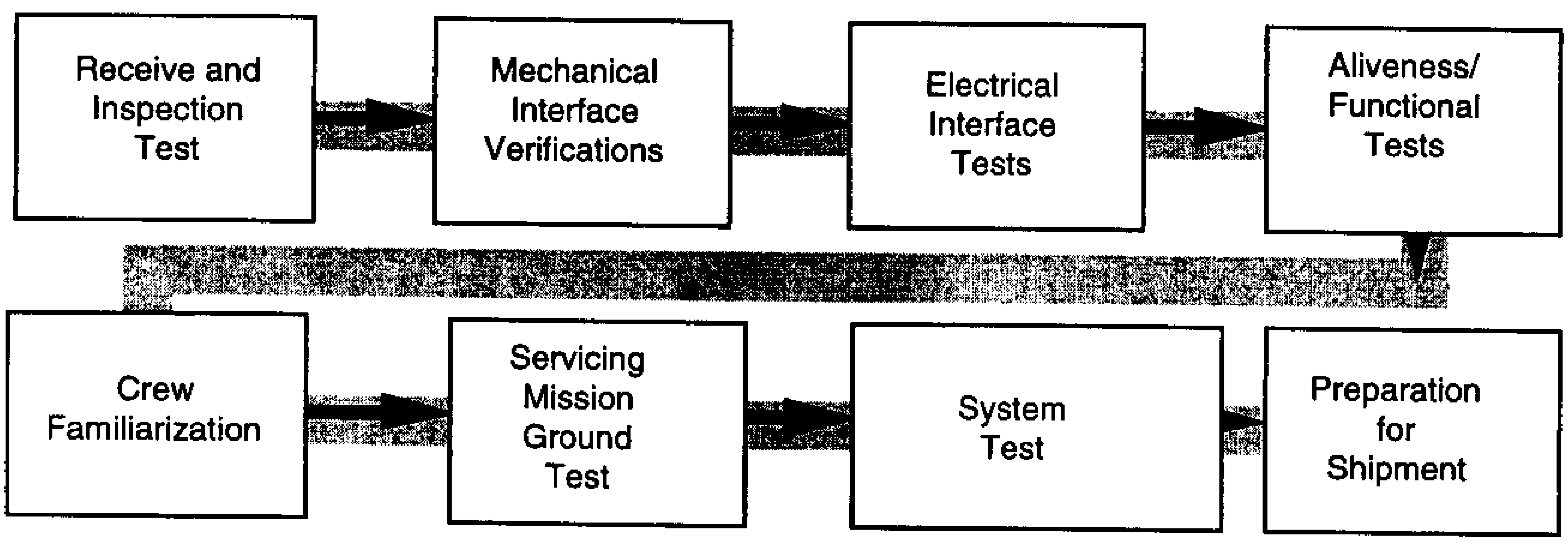

Figure 12-1. SA3/Diode Box Test Flow at GSFC

12.5 SA3/DIODE BOX MECHANICAL GROUND SUPPORT EQUIPMENT

The mechanical ground handling equipment for the SA3 consists of the following: SCN 001

- Solar Array Wing (SAW) Horizontal and Vertical Lift Slings
- Multi Use Fixture (MUF) Horizontal and Vertical Lift Slings
- Panel Lift Sling
- Solar Array Drive Mechanism (SADM) Mast Lift Sling
- MUF Strongback/Base
- Panel Shipping Container
- Upper Carrier Dolly
- Panel Rotating Frames
- SAW Integration Cradle
- GSE Latches

12.6 RECEIVING AND INSPECTION

The SA3 and Diode Boxes are shipped to GSFC after completing acceptance testing at the vendor location. The shipping containers are inspected for identification and damage. The SA3 and Diode Boxes are moved into the Clean Room and inspected for identification, damage, and cleanliness.

12.7 MECHANICAL VERIFICATION

This section presents information pertinent to the various mechanical aspects of the SA3 and Diode Boxes.

12.7.1 SA3 and Diode Boxes Fit Check into VEST SSM

The SA3 wings and Diode Boxes are mechanically integrated into and de-integrated from the VEST SSM. Procedures are developed and validated using the engineering models. An end-to-end sequence, including disconnecting the harness, removing and installing the Diode Boxes and connecting the harnesses is verified. The SA3 wings and Diode Boxes shall be in the flight configuration.

12.7.2 SA3/Diode Box Mounting Bolt to CAT Fit Check

A Fit Check is made with the appropriate CATs to each SA3/Diode Box Captive Mounting Bolt Head. SCN 001

12.7.3 Flight SA3/Diode Box to RAC Fit Test

The SA3 Wings and Diode Boxes are mechanically integrated into and deintegrated from the RAC. Procedures are developed and validated first using the EM SA3 and diode boxes.

12.8 ELECTRICAL INTERFACE TESTS

The EICIT and IVT are executed with BOBs and BOCs installed to isolate the SA3 from the associated test articles and facilitate point-to-point measurements. The EICIT is run first followed by the IVT. These interface tests verify that the SA3 meets requirements for the A- and B-Sides.

12.9 ALIVENESS TEST

The AT is initiated after the EICIT and IVT are successfully completed and the BOBs and BOCs are removed. The AT is a short test in which SA3 and diode boxes is powered-on for health and status checks. The AT starts with a planned shuttle phase (on-orbit) AT. The AT verifies electrical connections exit in all connectors that handle power, telemetry and commands. The on-orbit AT provides a quick-look on the A side of the SA3 followed by a switch to B side for a more detailed check with commands and telemetry responses. The VEST AT will provide a detailed check of both A and B sides.

12.10 FUNCTIONAL TESTS

The FT consists of sending various high level discrete commands to the SA3 and observing appropriate telemetry response. The B-side is verified to be properly functioning. The FT will be run with both a DF-224 and a HST486 Computer installed in VEST.

A VEST System Functional Test (SFT) demonstrates the functionality of the SA3 wings and Diode Boxes. The SFT will be run with both a DF-224 and a HST486 Computer installed in VEST.

12.11 CREW FAMILIARIZATION

Refer to Section 5.4.

12.12 SERVICING MISSION GROUND TEST

SMGT-SA3 (refer to Section 5.8) consists of a series of tests comprised of an AT and FT except that the commands come from STOCC instead of the VEST.

12.13 SYSTEM TEST

The flight SA3 wings and Diode Boxes shall be installed in the VEST and used to support the system level testing (refer to Section 5.9).

12.14 PREPARATION FOR SHIPMENT TO LAUNCH SITE

The flight SA3 Wings and D-boxes in final flight configuration shall be inspected, photographed, and placed in the transporter for transportation to KSC.

13. SSR TEST PROGRAM

13.1 SSR INTEGRATION AND TEST FLOW

The SSR-unique test program is defined in this section. Standard NASA/GSFC policies and guidelines are observed for all operations except where noted. The SSR test program imposes all standard administrative controls for readiness reviews, documentation, and performance verification requirements. Level III requirements are derived from STR-81. The test flow for the SSR at GSFC is illustrated in Figure 13-1.

13.2 ENVIRONMENTAL CONTROLS

Standard GSFC guidelines for an ambient environment will be followed.

13.3 CONTAMINATION CONTROL

A Class 100k environment will be maintained at all times up to and including launch.

13.4 SAFETY

Ground straps are attached between facility ground and the SSR enclosure at all times when the unit is out of its shipping container and not mounted to the VEST structure. Whenever practical, connector savers shall be used. All mating and demating of VEST electrical cabling is done with all SSR power relays open and the SSR grounded. All SSR mission critical hardware shall meet the ground safety requirements of KHB 1700.7B.

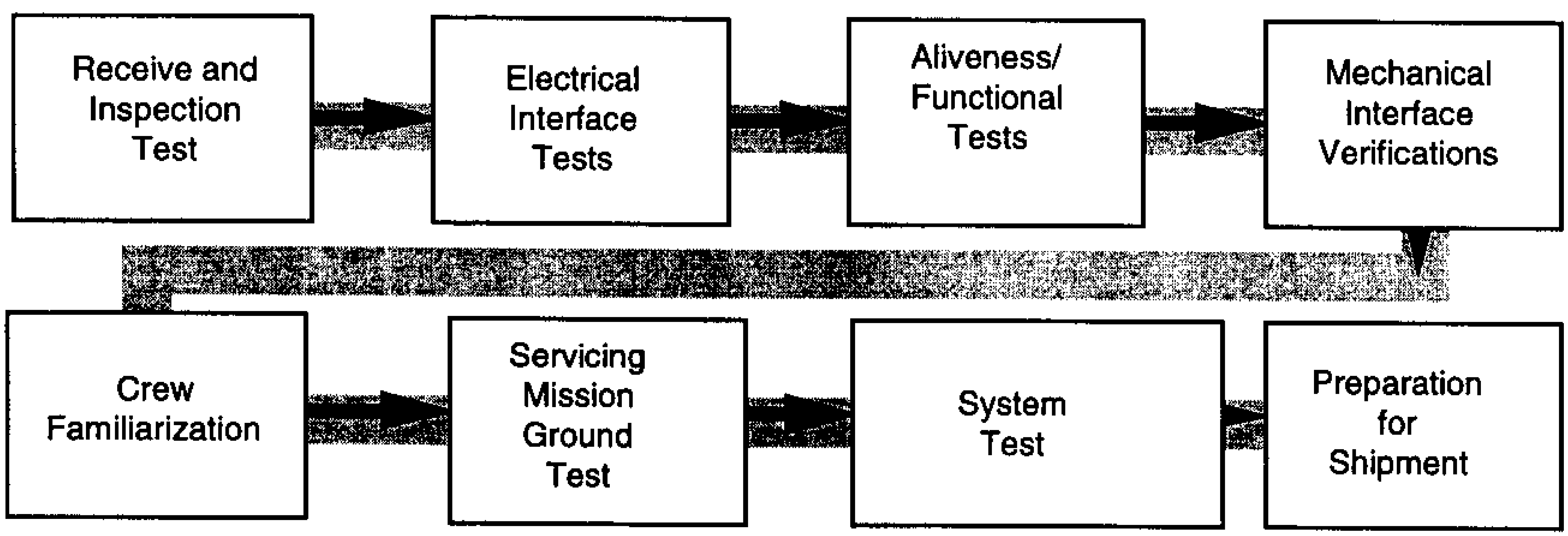

Figure 13-1. SSR Test Flow at GSFC

13.5 SSR MECHANICAL GROUND SUPPORT EQUIPMENT-

No special MGSE is used.

13.6 RECEIVING AND INSPECTION

The SSR is shipped to GSFC after completing acceptance testing at the vendor location. The shipping containers are inspected for identification and damage. The SSR is moved into the Clean Room and inspected for identification, damage, and cleanliness.

13.7 MECHANICAL VERIFICATION

This section presents information pertinent to the various mechanical aspects of the SSR.

13.7.1 SSR Fit Check into VEST SSM Bay 5 Position 3

The SSR is mechanically integrated into and deintegrated from the VEST SSM Bay 5 Position 3. Procedures are developed and validated using the thermal mass model SSR. An end-to-end sequence, including opening Bay 5 doors, disconnecting the harness, removing "T" Cable, installing the "J" harness, and installing the SSR is verified. The SSR shall be in its flight configuration.

13.7.2 SSR Mounting Bolt to CAT Fit Check

A fit check is made with the appropriate CATs to the flight SSR captive mounting bolt head.

13.7.3 Flight SSR to OPE Fit Test

The SSR is mechanically integrated into and deintegrated from the flight OPE. Procedures are developed and validated first using the thermal mass model SSR.

The "T" and "J" harnesses will be fitchecked into and deintegrated from the flight OPE.

13.8 ELECTRICAL INTERFACE TESTS

The EICIT and IVT are executed with BOBs and BOCs installed at the SSR/VEST harness interface to isolate the SSR from the associated test articles and facilitate point-to-point measurements. The EICIT is run first followed by the IVT. These interface tests verify that the SSR meets requirements for the A- and B-Sides.

13.9 ALIVENESS TEST

The AT is initiated after the EICIT and IVT are successfully completed and the BOBs and BOCs are removed. The AT is a short test in which the SSR is powered-on for health and status checks. The AT starts with a planned shuttle phase (on-orbit) AT. The AT verifies electrical connections exist in all connectors which to be disturbed during the EVA. During the on-orbit AT, which applies only to A-side interfaces, both SSR-1 and SSR-3 are powered on and subjected to brief uncaptured record and playback sessions. The VEST AT duplicates the on-orbit AT and adds a separate iteration of the test for the B-side interfaces. The test will be run with both a DF-224 and a HST486 computer installed in VEST.

13.10 FUNCTIONAL TESTS

The FT consists of sending various high level discrete commands to SSR-1 & 3 and observing appropriate telemetry response. The B-side is verified to be properly functioning. The FT will be run with both a DF-224 and a HST486 computer installed in VEST.

A VEST System Functional Test(SFT) demonstrates the functionality of both A- and B- sides of the SSR-1 & 3.

13.11 CREW FAMILIARIZATION

Refer to Section 5.4.

13.12 SERVICING MISSION GROUND TEST

SMGT-SSR (refer to Section 5.8) consists of a series of tests comprised of an AT and FT except that the commands come from STOCC instead of the VEST.

13.13 SYSTEM TEST

The flight SSR and flight "J" harness shall be installed in the VEST and used to support the system level testing (refer to Section 5.9).

13.14 PREPARATION FOR SHIPMENT TO LAUNCH SITE

The flight SSR in final flight configuration shall be inspected, photographed, and placed in the OPE for transportation to KSC.

14. RSU TEST PROGRAM

14.1 RSU INTEGRATION AND TEST FLOW

The RSU-unique test program is defined in this section. Standard NASA/GSFC policies and guidelines are observed for all operations except where noted. The RSU test program imposes all standard administrative controls for readiness reviews, documentation, and performance verification requirements. Level III requirements are derived from STR-81. The Rate Gyro Assembly (RGA) is made up of a RSU and Electronic Control Unit (ECU) and tested as a set. The test flow for the RSU at GSFC is illustrated in Figure 14-1.

14.2 ENVIRONMENTAL CONTROLS

Standard GSFC guidelines for an ambient environment will be followed.

14.3 CONTAMINATION CONTROL

A Class 10k environment will be maintained at all times up to and including launch.

14.4 SAFETY

Ground straps are attached between facility ground and the RGA enclosure at all times when out of its shipping container. Whenever practical, connector savers shall be used. All mating and demating of VEST electrical cabling is done with all PDU/RGA

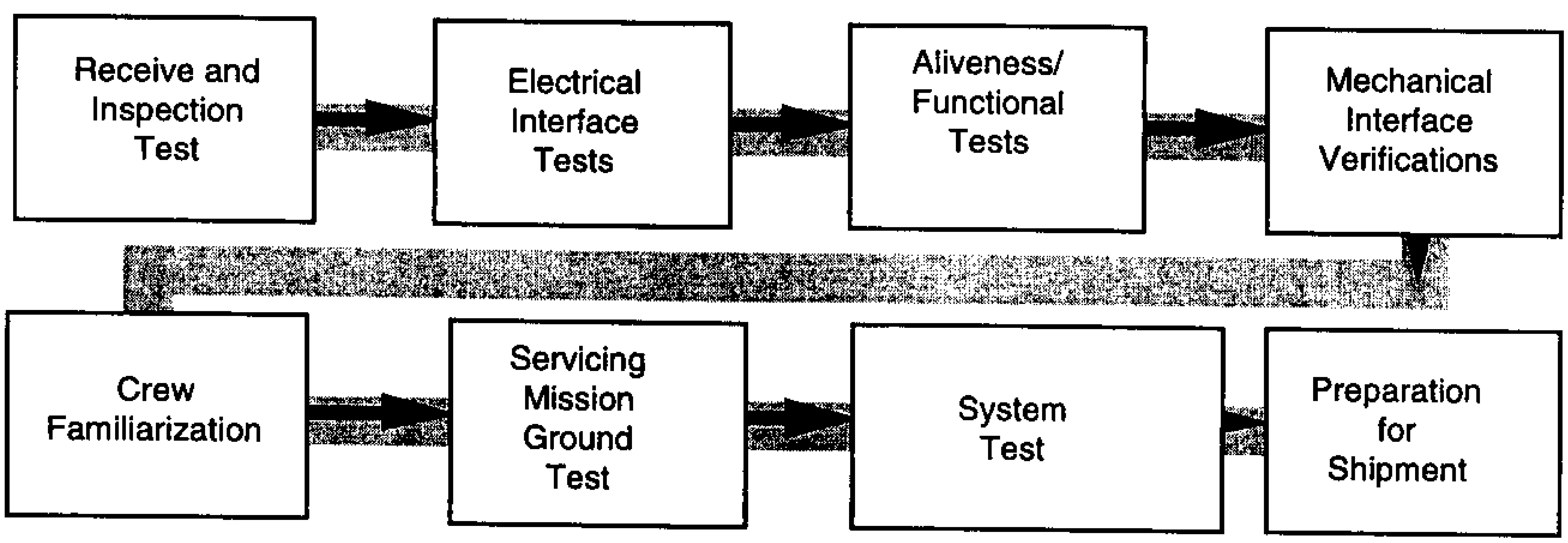

Figure 14-1. RSU Test Flow at GSFC

relays open and the RGA grounded. All RGA mission critical hardware shall meet the ground safety requirements of KHB 1700.7B.

14.5 RGA MECHANICAL GROUND SUPPORT EQUIPMENT

No special MGSE is used.

14.6 RECEIVING AND INSPECTION

The RSU is shipped to GSFC after completing acceptance testing at the vendor location. The shipping containers are inspected for identification and damage. The RSU is moved into the Clean Room and inspected for identification, damage, and cleanliness.

14.7 MECHANICAL VERIFICATION

This section presents information pertinent to the various mechanical aspects of the RSU.

14.7.1 RSU Fit Check into HFMS

Each RSU is mechanically integrated into and deintegrated from the HFMS. Procedures were developed and validated using the EM RGA in preparations for SM1. An end-to-end sequence, including opening Bay doors, disconnecting the harness, removing and installing the RSU is verified. The RSU shall be in its flight configuration.

14.7.2 RSU Mounting Bolt to CAT Fit Check

A fit check is made with the appropriate CATs to each flight RSU captive mounting bolt head.

14.7.3 Flight RSU to OPE Fit Test

The RSU is mechanically integrated into and deintegrated from the flight OPE. Procedures are developed and validated first using the EM RSU.

14.8 ELECTRICAL INTERFACE TESTS

The EICIT and IVT are executed with BOBs and BOCs installed to isolate the RGA from the associated test articles and facilitate point-to-point measurements. The EICIT is run first followed by the IVT. These interface tests verify that the RGA meets requirements for the A- and B-Sides.

14.9 ALIVENESS TEST

The AT is initiated after the EICIT and IVT are successfully completed and the BOBs and BOCs are removed. The AT is a short test in which RGA is powered-on for health and status checks. The AT starts with a planned shuttle phase (on-orbit) AT. The AT verifies electrical connections exist in all connectors that handle power, telemetry and commands. The VEST AT will provide a detailed check of both A and B sides. The AT will be run with both a DF-224 and a HST486 computer installed in VEST.

14.10 FUNCTIONAL TESTS

The FT consists of sending various high level discrete commands to RGA A-side and observing appropriate telemetry response. The FT will be run with both a DF-224 and a HST486 computer installed in VEST.

A VEST System Functional Test demonstrates the functionality of both A- and B- sides of the RGA. The SFT will be run with both a DF-224 and a HST486 computer installed in VEST.

14.11 CREW FAMILIARIZATION

Refer to Section 5.4.

14.12 SERVICING MISSION GROUND TEST

SMGT-RGA (refer to Section 5.8) consists of a series of tests comprised of an AT and FT except that the commands come from STOCC instead of the VEST.

14.13 SYSTEM TEST

The flight RSU shall be installed in the VEST and used to support the system level testing (refer to Section 5.9).

14.14 PREPARATION FOR SHIPMENT TO LAUNCH SITE

The flight RSU in final flight configuration shall be inspected, photographed, and placed in the OPE for transportation to KSC.

15. AFT SHROUD COOLING SYSTEM/NICMOS COOLING SYSTEM TEST PROGRAM

15.1 ASCS/NCS INTEGRATION AND TEST FLOW

The SI-unique test program for the ASCS/NCS is defined in this section. Standard NASA/GSFC policies and guidelines are observed for all operations except where noted. The SI test program im-poses all standard administrative controls for readiness reviews, documentation, and performance verification requirements. Level III requirements are derived from STR-81. The test flow for the ASCS/NCS at GSFC is illustrated in Figure 15-1.

15.2 ENVIRONMENTAL CONTROLS

The SI test program imposes standard ambient environment require-ments as stated in Section 3.3 of this document.

15.3 CONTAMINATION CONTROL

The ASCS/NCS is bagged prior to shipment. A class 10k clean room environment is required for receiving and inspection. The in-strument remains bagged at all times except when the bag is opened for a specific integration or test activity. The 10k cleanliness level shall be maintained at all times up to and including launch.

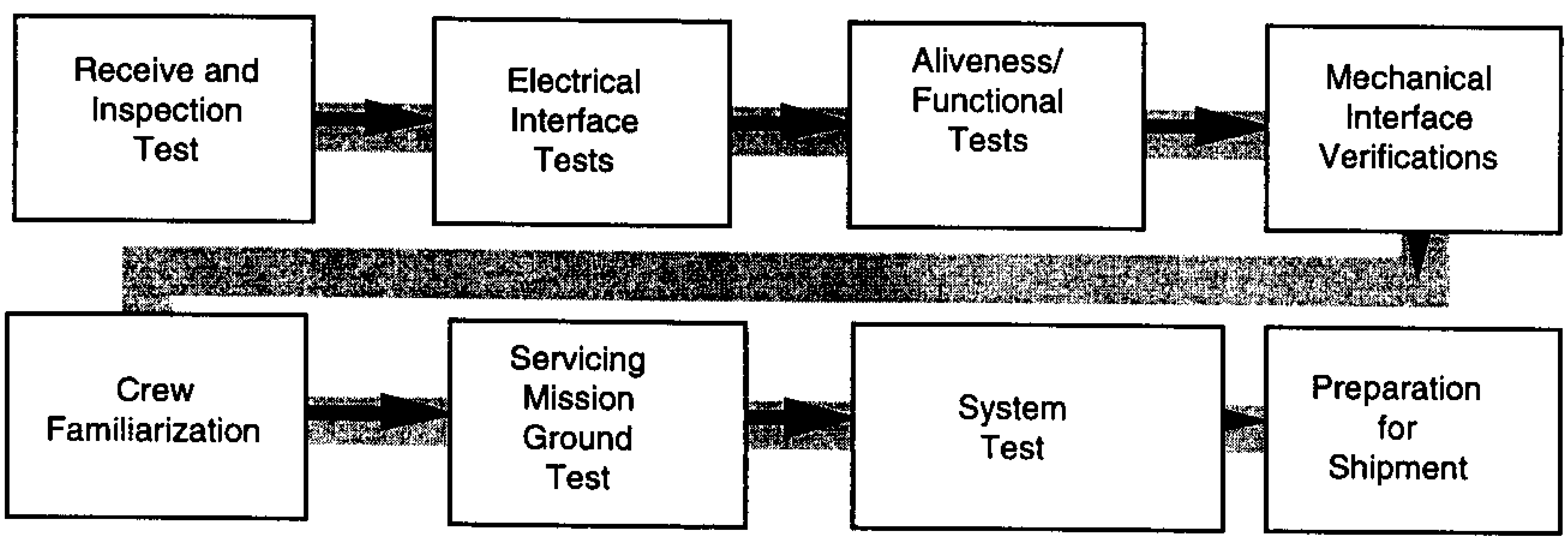

Figure 15-1. ASCS/NCS Test Flow at GSFC

15.4 SAFETY

The ASCS/NCS Volume Simulator is used for handling training and initial fit checks prior to the checks with ASCS/NCS. Slings, lifting fixtures, and facilities used to lift flight hardware is certified by quality assurance and safety for use prior to actual lifting. All ASCS/NCS mission critical hardware meet the standard ground safety requirements are imposed as stated in Section 3.5 of this document.

Whenever practical, connector savers shall be used. All mating and demating is done with all four PDU relays open and the instrument grounded. Special handling applies to the radiators due to the presence of ammonia filled heat pipes.

15.5 ASCS/NCS GROUND SUPPORT EQUIPMENT

The ASCS/NCS MGSE and EGSE used to support I&T activities are listed in the following subsections.

15.5.1 ASCS/NCS Mechanical Ground Support Equipment

The mechanical ground handling equipment for the ASCS/NCS consists of the following equipment: SCN 001

- ASCS Radiator-MULE Lift Fixture
- NCS Radiator MULE Lift Fixture
- NCS/ASCS Radiator Mass Properties Fixture

- NICMOS Cryogenic Cooler (NCC) Anti-Gravity Machine (AGM) Support Fixture
- NCC-HFMS Fixture
- Electronic Support Module (ESM)-HFMS Fixture
- NCS Radiator-HFMS Fixture
- ASCS Radiator-HFMS Fixture

SCN 001

15.5.2 ASCS/NCS Electrical Ground Support Equipment

The Cooling Hardware Environmental System Testbed (CHEST) is being developed to support the integration and test of the various subsystems into the ASCS/NCS. This system will also be used at GSFC for the assembled system environmental test program that is being conducted prior to the hardware being delivered to I&T.

15.6 HANDLING, TRANSPORTATION, AND STORAGE (Deleted) SCN 001

15.7 RECEIVING AND INSPECTION

The flight hardware and supporting GSE is unpacked and undergoes R&I. The I&T Team, consisting of mechanical engineers, hardware representatives, and flight assurance representatives, perform the R&I in accordance with approved procedures. These procedures, as a minimum, identify unpacking requirements, handling constraints, mechanical tasks, responsibility, facilities, GSE, and safety constraints. Standard GSFC guidelines for an R&I are imposed as stated in Section 5.2.

15.8 POST-SHIPMENT TEST

There is no post shipment test since the integration of ASCS/NCS and the environmental test program is being conducted at GSFC.

15.9 MECHANICAL VERIFICATIONS

This section presents information pertinent to the various mechanical verification aspects of the instrument (refer to Section 5.3).

15.9.1 Volumetric Measurements

Prior to installation of the ASCS/NCS onto the MULE, or HFMS, critical mechanical envelope and attachment interfaces must be verified. The ASCS/NCS external envelope is verified per requirements in ST-ICD-98 prior to shipment to GSFC using procedures and equipment developed by GSFC. These interfaces include: for the ESM and NCC, the two latch locations latch orientations, the external envelope; for the radiators, the three radiator latch locations for each radiator and orientation, the external envelope and alignment positions. If any modifications to the flight hardware are made after this envelope verification at the hardware developers, additional measurements are required at GSFC to ensure compatibility with the MULE and HST (including the HFMS). The same procedures used to verify these envelopes at the hardware developer apply at GSFC.

15.9.2 Cooling Operations

ASCS/NCS requires cooling operations at GSFC. The handling of radiators may be a hazardous operation that requires special safety procedures and equipment to perform. The vendor shall provide the procedures in accordance with appropriate safety guidelines for this process.

15.9.3 ASCS/NCS-to-MULE Fit Test

The ASCS/NCS arrives on the appropriate handling dolly. The instrument is moved into place and the ASCS/NCS lifting sling attached. The hardware is then lifted by the crane/hydraset assembly and the dolly removed. The MULE will have been leveled and readied for installation of the instrument.

15.9.4 ASCS/NCS-to-HFMS Fit Tests

ASCS/NCS is placed into the HFMS by the appropriate MGSE. These tests verify latch positions, instrument envelope, cooling lines and the electrical connector interfaces.

15.9.5 EVA Crew Aid/Tool Check

All crew aid and tool testing not performed by the vendor shall be accomplished in the clean room with the SI in the HFMS, MULE, or on the handling dolly. The EVA interfaces are fit-checked and, if practical, functionally tested.

15.10 ELECTRICAL INTERFACE TEST

The EICIT and IVT (refer to Section 5.5) are executed with BOBs and BOCs installed to isolate ASCS/NCS from the associated test articles and facilitate point-to-point measurements. The EICIT is run first followed by the IVT. The BOBs and BOCs are removed after successful completion of the IVT.

15.10.1 Electrical Interface Continuity and Isolation Test

The EICIT verifies that the continuity, impedance, and isolation characteristics of all ground, power bus, and input/output signal lines between the ASCS/NCS and VEST comply with the specifica-tions detailed in ST-ICD-08 and ST-ICD-98.

15.10.2 Interface Verification Test

The IVT verifies the initial power-on and control signal characeristics of the interface between the ASCS/NCS, VEST test harness, and the associated VEST EGSE.

15.10.2.1 Initial Power-On Checks.

These checks are executed with only the power and ground connections jumpered to pass through the BOBs. Both the primary and redundant side of ASCS/NCS shall be checked. These checks measure and record the initial power-on states of ASCS/NCS including:

- In-Rush Current is measured using the appropriate test instrumentation at the BOB connected closest to the ASCS/NCS
  input power connector(s) when powering-on the system. The power-on sequence energizes RIUs first, verifies relay configuration, energizes hold bus, and finally, if safe and practical, energizes the operate bus.
- Steady State Power Levels are measured using the appropriate test instrumentation at the same point as the In-Rush Current Checks are made to measure the quiescent power state of the instrument.
- Stray Voltage Checks are made on the ASCS/NCS connectors.

15.10.2.2 Control Signal Verification These checks are made with all ASCS/NCS power, ground, and signal I/O connections jumpered to pass through the BOBs. This test verifies the functionality of all lines in the interface and the assignments of the ASCS/NCS input/output drivers and/or receiver lines. The telemetry data transfer function is tested to demonstrate that the input/output drivers and/or receivers are correctly assigned and match up to one another. This test verifies the control signals to ASCS/NCS by activating specified functions on and off to ensure the correct response. The telemetry data lines are checked to verify they are within the minimum and maximum specifications for ASCS/NCS.

15.11 ALIVENESS TEST

The AT is a short power-on test to perform health and status checks (refer to Section 5.6). The AT starts with a replica of the planned Shuttle Phase (on-orbit) AT. The AT verifies electrical connections in all EVA connectors that comprise the power, engineering telemetry, and internal data paths. Telemetry is monitored to verify that the power and thermal values (if available) are within acceptable ranges. At the end of the AT, ASCS/NCS is left in the thermal safe mode. From the thermal safe mode, ASCS/NCS can be sequenced to the mode of operation required for the next test(s). The outline of the basic AT is:

ASCS:

- Apply COSTAR Power and verify RIU-A and RIU-B functionality
- Power on Microcontroller to Boot State
- Transition Microcontroller to Operate State
- Transition ASCS/ESM to safe state
- Verify CASH connectivity

NCS:

- Power on NCS Survival Heaters
- Power on Microcontroller to Boot state
- Transition Microcontroller to Operate State
- Power on NCC Power Control Electronics to verify system pressures
- Transition ASCS/NCS to Safe

15.12 SAFING AND RECOVERY TEST

This test is a subset of the developers test that verifies the operation of the safing processor. Successful completion of the following routine demonstrates the capability of the instrument to communicate with the NSSC-I:

- Initiate safing for the NCC
- Initiate safing for the NCS CPL
- Initiate safing for the ACS-1 CPL
- Initiate safing for ACS-2 CPL
- Initiate safing for STIS CPL
- Initiate safing for COS CPL
- Initiate Suspend of ASCS/NCS
- Initiate safing for ASCS/NCS

CCLs and stored command procedures for the instrument recovery after safing will be fully tested with ASCS/NCS and VEST.

15.13 FUNCTIONAL TEST

The FT is a replica of the functional test planned for the Shuttle Phase (refer to Section 5.7). The FT verifies that major elements within ASCS/NCS are functioning correctly. It is not the purpose of this test to determine the detailed functional operations of all items, but rather that subsystems operate and that major instrument functional states (e.g., survival heater power, Microprocessor FSW, operational heater power, NCC rotating components, etc.) operate as designed. Additionally, critical mechanism operations are verified to the extent possible.

The developers test results shall be used as the criteria to evaluate the VEST FT results. There are presently no limitations within the VEST system to prevent performance of these tests; however, ASCS/NCS constraints and restrictions may prevent full implementation of the development procedures.

15.14 SYSTEM FUNCTIONAL TEST

The System Functional Test exercises the instrument functions by running many of the operational modes utilizing as many command structures as possible. The System Test is performed on both sides of the instrument.

15.15 SOFTWARE

ASCS/NCS-unique software validated during I&T activities consists of:

- NSSC-I flight software
- 8051 flight software

15.16 CREW FAMILIARIZATION

Refer to Section 5.4.

15.17 GROUND SYSTEM TEST

ASCS/NCS shall be used for SMGT-ASCS/NCS (refer to Section 5.8). This SMGT is executed in conjunction with the STOCC and other appropriate HST operations support facilities. This test demonstrates compatibility between the HST ground and flight systems by validating the STOCC operations real-time commanding, command loads, and telemetry processing. The SMGT utilizes all appropriate operations elements of the GSFC ground systems, facilities, and personnel. This testing also demonstrates the capability of the Ground System, flight software systems, Servicing Mission PDB, scheduling, and commanding for ASCS/NCS operations. The SMGT includes servicing mission operations that can be safely performed in the VEST environment.

15.18 SYSTEM LEVEL TEST

ASCS/NCS shall be used to support the system level testing. (refer to Section 5.9).

SCN 001

15.19 PREPARATION FOR SHIPMENT

At the completion of GSFC I&T activities the ASCS/NCS will be inspected and photographed. The unit will then be installed onto the MULE in final flight configuration. The MULE will be placed in the FSS shipping container, which will be shipped to KSC in an air-ride van.

16. VOLTAGE/TEMPERATURE IMPROVEMENT KIT PROGRAM

16.1 VIK INTEGRATION AND TEST FLOW

The Voltage/Temperature Improvement Kit (VIK)-unique test program is defined in this section. Standard NASA/GSFC policies and guidelines are observed for all operations except where noted. The VIK test program imposes all standard administrative controls for readiness reviews, documentation, and performance verification requirements. Level III requirements are derived from STR-81. The test flow for the VIK at GSFC is illustrated in Figure 16-1.

16.2 ENVIRONMENTAL CONTROLS

Standard GSFC guidelines for an ambient environment will be followed.

16.3 CONTAMINATION CONTROL

A Class 100k environment will be maintained at all times up to and including launch.

16.4 SAFETY

Ground straps are attached between facility ground and the VIK enclosure at all times when out of its shipping container. Whenever practical, connector savers shall be used. All mating and demating of VEST electrical cabling is done with all VIK interfaces dead faced and with the VIK grounded. All VIK

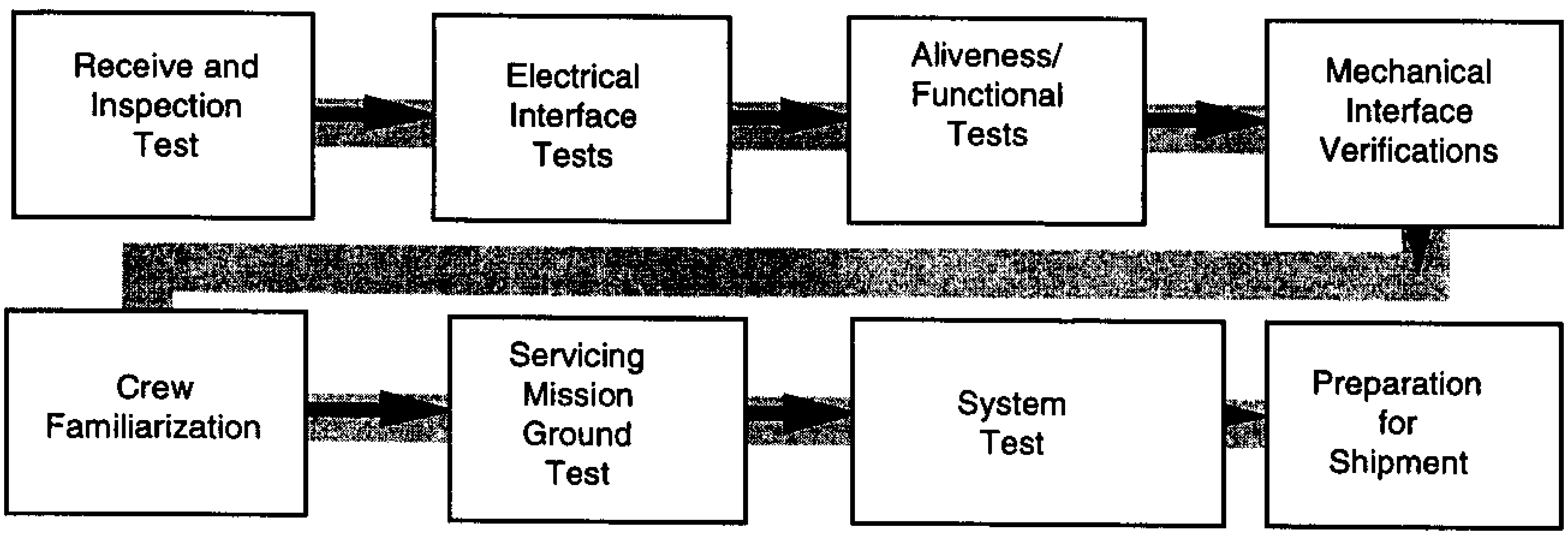

Figure 16-1 VIK Integration And Test Flow

mission critical hardware shall meet the ground safety requirements of KHB 1700.7B.

16.5 VIK MECHANICAL GROUND SUPPORT EQUIPMENT

No special MGSE is used.

16.6 RECEIVING AND INSPECTION

The VIK is shipped to GSFC after completing acceptance testing at the vendor location. The shipping containers are inspected for identification and damage. The VIK is moved into the Clean Room and inspected for identification, damage, and cleanliness.

16.7 MECHANICAL VERIFICATION

This section presents information pertinent to the various mechanical aspects of the VIK.

16.7.1 VIK Fit Check into VEST SSM Bays 2 & 3

The VIK is mechanically integrated into and deintegrated from the VEST SSM Bays 2 and 3. Procedures are developed and validated using the EM VIK. An end-to-end sequence, including opening Bay doors, disconnecting the harness, removing and installing the VIK is verified. The VIK shall be in its flight configur

16.7.2 Flight VIK to OPE Fit Test

The VIK with associated cabling is mechanically integrated into and deintegrated from the flight OPE. Procedures are developed and validated first using the EM VIK.

16.8 ELECTRICAL INTERFACE TESTS

The EICIT and IVT are executed with BOBs and BOCs installed to isolate the VIK from the associated test articles and facilitate point-to-point measurements. The EICIT is run first followed by the IVT.

16.9 ALIVENESS TEST

The AT is initiated after the EICIT and IVT are successfully completed and the BOBs and BOCs are removed. The AT is a short test in which the VIK is powered for health and status checks. The AT starts with a planned shuttle phase (on-orbit) AT. The AT verifies electrical connections exist in all connectors that handle power, telemetry and commands. The on-orbit AT provides a detailed check with commands and telemetry responses. The AT will be run with both a DF-224 and a HST486 Computer installed in VEST.

16.10 FUNCTIONAL TESTS

The FT consists of sending various high level discrete commands to the CCC while only on simulated HST internal main power and confirm the offset of the K1 and K2 charge level through observing appropriate telemetry response. The FT will be run with both a DF-224 and a HST486 Computer installed in VEST.

A VEST System Functional Test (SFT) demonstrates the functionality of the VIK. The SFT will be run with both a DF-224 and a HST486 Computer installed in VEST.

16.11 CREW FAMILIARIZATION

Refer to Section 5.4.

16.12 SERVICING MISSION GROUND TEST

SMGT-VIK (refer to Section 5.8) consists of a series of tests comprised of an AT and FT except that the commands come from STOCC instead of the VEST.

16.13 SYSTEM TEST

The flight VIK shall be installed in the VEST and used to support the system level testing (refer to Section 5.9).

16.14 PREPARATION FOR SHIPMENT TO LAUNCH SITE

The flight VIK in final flight configuration shall be inspected, photographed, and placed in the OPE for transportation to KSC.

17. NEW OUTER BLANKET LAYER/SHIELD/SHELL REPLACEMENT FABRIC

17.1 NEW OUTER BANKET LAYER/SHIELD/SHELL REPLACEMENT FABRIC INTEGRATION AND TEST FLOW

The New Outer Blanket Layer (NOBL)/Shield/Shell Replacement Fabric (SSRF)-unique test program is defined in this section. Standard NASA/GSFC policies and guidelines are observed for all operations except where noted. The NOBL/SSRF test program imposes all standard administrative controls for readiness reviews, documentation, and performance verification requirements. Level III requirements are derived from STR-81. The test flow for the NOBL at GSFC is illustrated in Figure 17-1.

17.2 ENVIRONMENTAL CONTROLS

Standard GSFC guidelines for an ambient environment will be followed.

17.3 CONTAMINATION CONTROL

A Class 100K environment will be maintained at all times up to and including launch.

17.4 SAFETY

All NOBL/SSRF mission critical hardware shall meet the ground safety requirements of KHB 1700.7B.

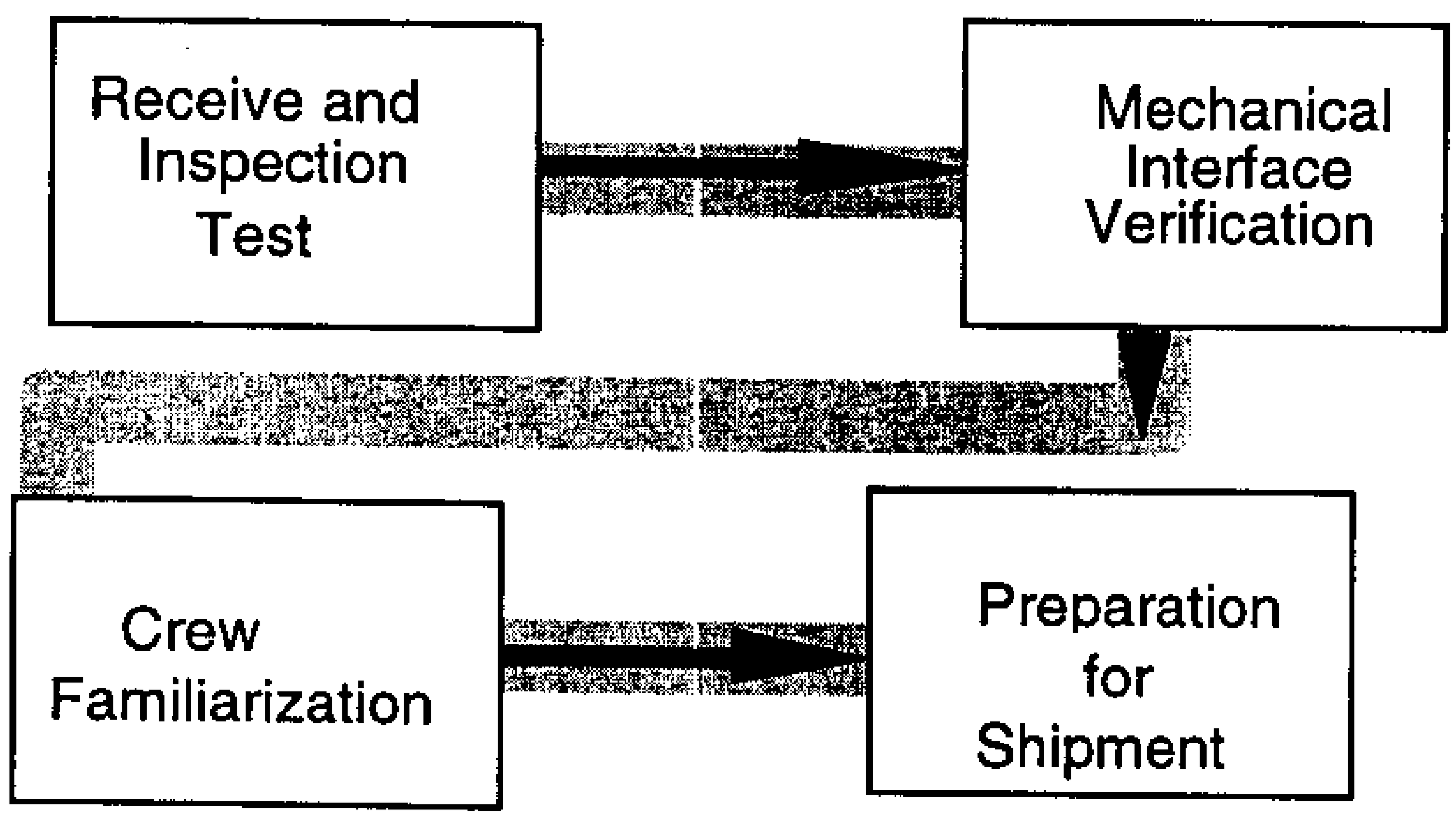

Figure 17-1 NOBL/SSRF Test Flow at GSFC

17.5 NOBL/SSRF MECHANICAL GROUND SUPPORT EQUIPMENT

No special MGSE is used.

17.6 RECEIVING AND INSPECTION

The NOBL/SSRF is shipped to GSFC after completing acceptance testing at the vendor location. The shipping containers are inspected for identification and damage. The NOBL/SSRF is moved into the Clean Room and inspected for identification, damage, and cleanliness.

17.7 MECHANICAL VERIFICATION

This section presents information pertinent to the various mechanical aspects of the NOBL/SSRF.

17.7.1 NOBL/SSRF Fit Check

The NOBL/SSRF is mechanically integrated into and deintegrated from the HST External Simulator Facility (ESF). The NOBL/SSRF shall be in its flight configuration.

17.7.2 NOBL/SSRF to CAT Fit Check

A fit check is made with the appropriate CATs to the flight NOBL/SSRFs.

17.7.3 Flight NOBL to NPE Fit Test

The NOBL is mechanically integrated into and deintegrated from the flight NOBL Protective Enclosures (NPE).

17.7.4 Flight SSRF to OPE Fit Test

The SSRF is mechanically integrated into and deintegrated from its protective enclosure - either the flight Shield Shell Replacement Fabric (SSRF) Bundled Retention Device (BRD) or the ASIPE contingency shelf.

17.8 ELECTRICAL INTERFACE TESTS

There are no electrical interface tests required.

17.9 ALIVENESS TEST

There is no Aliveness Test required.

17.10 FUNCTIONAL TESTS

There is no Functional test required.

17.11 CREW FAMILIARIZATION

Refer to Section 5.4.

17.12 SERVICING MISSION GROUND TEST

No SMGT is required.

17.13 SYSTEM TEST

NOBL/SSRF will not be required for the full up Servicing Mission System Test.

17.14 PREPARATION FOR SHIPMENT TO LAUNCH SITE

NOBL/SSRF in final flight configuration shall be inspected, photographed, and placed in the OPE for transportation to KSC.

18. S-BAND SINGLE ACCESS TRANSMITTER PROGRAM

18.1 SSAT INTEGRATION AND TEST FLOW

The SSAT-unique test program is defined in this section. Standard NASA/GSFC policies and guidelines are observed for all operations except where noted. The SSAT test program imposes all standard administrative controls for readiness reviews, documentation, and performance verification requirements. Level III requirements are derived from STR-81. The test flow for the SSAT at GSFC is illustrated in Figure 18-1.

18.2 ENVIRONMENTAL CONTROLS

Standard GSFC guidelines for an ambient environment will be followed.

18.3 CONTAMINATION CONTROL

A Class 100k environment will be maintained at all times up to and including launch.

18.4 SAFETY

Ground straps are attached between facility ground and the SSAT enclosure at all times when out of its shipping container. Whenever practical, connector savers shall be used. All mating and demating of VEST electrical cabling is done with all PDU/SSAT relays open and the SSAT grounded. All SSAT mission

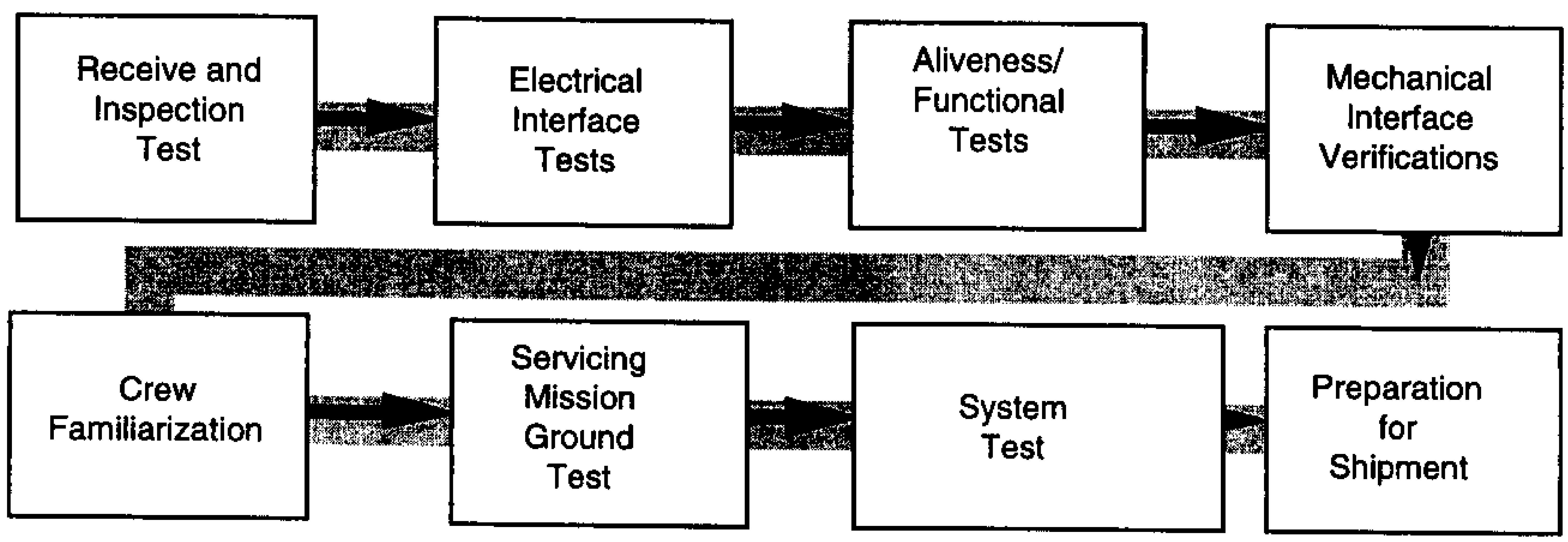

Figure 18-1. SSAT Test Flow at GSFC

critical hardware shall meet the ground safety requirements of KHB 1700.7B.

18.5 SSAT MECHANICAL GROUND SUPPORT EQUIPMENT

No special MGSE is used.

18.6 RECEIVING AND INSPECTION

The SSAT is shipped to GSFC after completing acceptance testing at the vendor location. The shipping containers are inspected for identification and damage. The SSAT is moved into the High Top Clean Room and inspected for identification, damage, and cleanliness.

18.7 MECHANICAL VERIFICATION

This section presents information pertinent to the various mechanical aspects of the SSAT.

18.7.1 SSAT Fit Check into VEST SSM Bay 5

The SSAT is mechanically integrated into and deintegrated from the VEST SSM Bay 5 Position 2. Procedures are developed and validated using the EM SSAT. An end-to-end sequence, including opening Bay 5 doors, disconnecting the harness, removing and installing the SSAT is verified. The SSAT shall be in its flight configuration.

18.7.2 SSAT Mounting Bolt to CAT Fit Check

A fit check is made with the appropriate CATs to each flight SSAT captive mounting bolt head.

18.7.3 Flight SSAT to OPE Fit Test

The SSAT with associated cabling is mechanically integrated into and deintegrated from the flight OPE. Procedures are developed and validated first using the EM SSAT.

18.8 ELECTRICAL INTERFACE TESTS

The EICIT and IVT are executed with BOBs and BOCs installed to isolate the SSAT from the associated test articles and facilitate point-to-point measurements. The EICIT is run first followed by the IVT. These interface tests verify that the SSAT meets requirements for the A Side.

18.9 ALIVENESS TEST

The AT is initiated after the EICIT and IVT are successfully completed and the BOBs and BOCs are removed. The AT is a short test in which SSAT is powered-on for health and status checks. The AT starts with a planned shuttle phase (on-orbit) AT. The AT verifies electrical connections exit in all connectors that handle power, telemetry and commands. The on-orbit AT provides a quick-look on the A side of the SSAT. The VEST AT will provide a detailed check of both A and B sides. The AT will be run with both a DF-224 and a HST486 Computer installed in VEST.

18.10 FUNCTIONAL TESTS

The FT consists of sending various high level discrete commands to SSAT-2 and observing appropriate telemetry response. The FT will be run with both a DF-224 and a HST486 Computer installed in VEST.

A VEST System Functional Test demonstrates the functionality of the A side of the SSAT-2. The SFT will be run with both a DF-224 and a HST486 Computer installed in VEST.

18.11 CREW FAMILIARIZATION

Refer to Section 5.4.

18.12 SERVICING MISSION GROUND TEST

SMGT-SSAT (refer to Section 5.8) consists of a series of tests comprised of an AT and FT except that the commands come from STOCC instead of the VEST. This test will be run with the SSAT radiating into a dummy load installed in VEST and will not use the TDRSS network.

TDRSS compatibility will be performed as part of the SSAT unit level testing performed prior to its delivery to the I&T phase of the test program.

18.13 SYSTEM TEST

The flight SSAT shall be installed in the VEST and used to support the system level testing (refer to Section 5.9).

18.14 PREPARATION FOR SHIPMENT TO LAUNCH SITE

The flight SSAT in final flight configuration shall be inspected, photographed, and placed in the OPE for transportation to KSC.

19. POWER CONTROL UNIT

19.1 PCU INTEGRATION AND TEST FLOW

The Power Control Unit (PCU)-unique test program is defined in this section. Standard NASA/GSFC policies and guidelines are observed for all operations except where noted. The PCU test program imposes all standard administration controls for readiness reviews, documentation, and performance verification requirements. Level III requirements are derived from STR-81. The test flow for the PCU at GSFC is illustrated in Figure 19-1.

19.2 ENVIRONMENTAL CONTROLS

Standard GSFC guidelines for an ambient environment will be followed.

19.3 CONTAMINATION CONTROL

A Class 100K environment will be maintained at all times up to and including launch.

19.4 SAFETY

Ground straps are attached between facility ground and the PCU E1 Ground Lug at all times when out of its shipping container. Whenever practical, connector savers shall be used. A Log of all Mate/Demates shall be maintained in the PCU Log Book. All mating and demating of VEST electrical cabling is done with the PCU

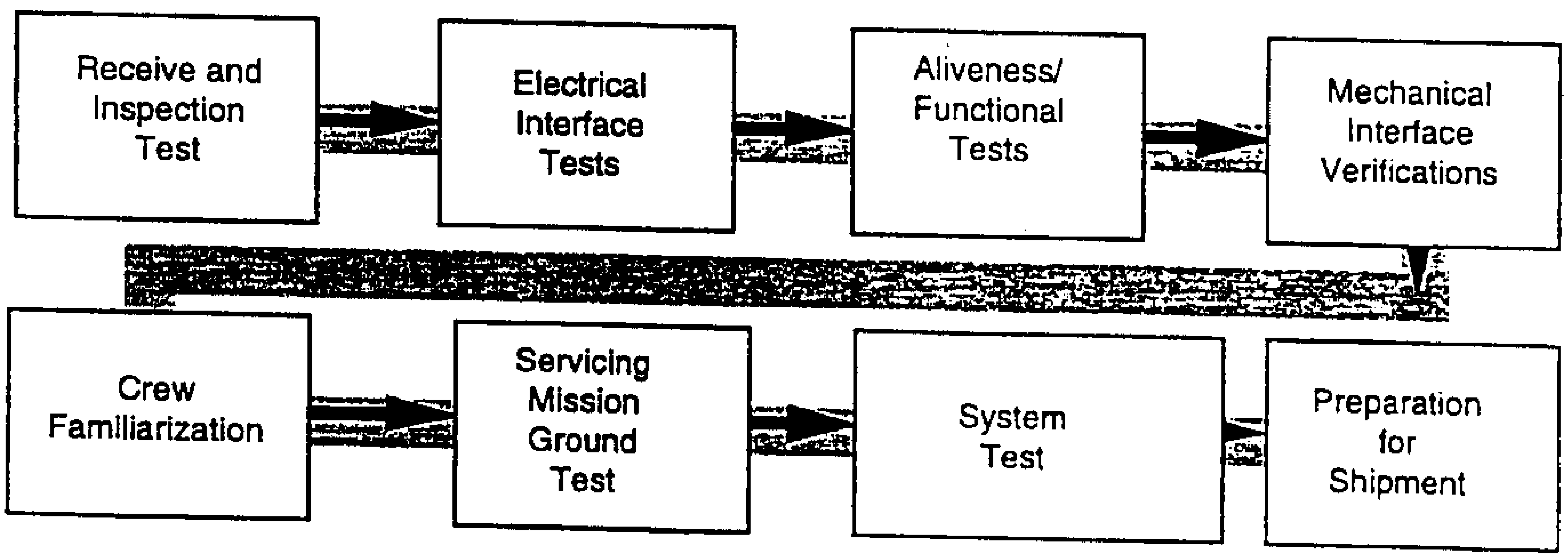

Figure 19-1 PCU Test Flow at GSFC

grounded. All PCU mission critical hardware shall meet the ground safety requirements of KHB 1700.7.

19.5 PCU MECHANICAL GROUND SUPPORT EQUIPMENT

When not installed into the VEST, the PCU shall be supported by standoffs to keep the tether loop hardware above the supporting structure. All PCU lifts shall be performed using procedure P-442-2429.

The Mechanical Ground Support Equipment for the PCU is:

PCU Pickle Fork Adaptor

19.6 RECEIVING AND INSPECTION

The PCU is shipped to GSFC after completion of acceptance testing at the vendor location. The shipping containers are inspected for identification and damage. The PCU is moved into the High Top Clean Room and inspected for identification, damage, and cleanliness.

19.7 MECHANICAL VERIFICATION

This section presents information pertinent to the various mechanical aspects of the PCU.

19.7.1 PCU Fit Check into VEST SSM Bay 4

The PCU is mechanically integrated into and deintegrated from the VEST SSM Bay 4. An end-to-end sequence, including opening Bay 4 doors, disconnecting the harness, and removing and installing the PCU is verified. The PCU shall be in its flight configuration.

19.7.2 PCU Mounting Bolt to CAT Fit Check

A fit check is made with the appropriate CATS to each flight PCU captive mounting bolt head and the E1 Ground Lug Bolt.

19.7.3 PCU to SAC Fit Check

The PCU is mechanically integrated and de-integrated from the flight SAC. Procedures are developed and validated first using the Engineering Model (EM) PCU.

19.8 ELECTRICAL INTERFACE TESTS

The EICIT and IVT are executed with BOBs and BOCs installed to isolate the PCU from the associated test articles and facilitate point-to point measurements. The EICIT is performed prior to the IVT. These interface tests verify that the PCU meets electrical requirements.

19.9 ALIVENESS TEST

The AT is initiated after the EICIT and the IVT are successfully completed and the BOBs and BOCs are removed. The AT is a short test with the PCU powered-on for health and status checks. The AT starts with a planned Shuttle phase (on-orbit) AT. The AT verifies electrical connections exist in all connectors that handle power, telemetry and commands.

19.10 FUNCTIONAL TESTS

The FT verifies, to the extent possible, the capability to perform mission critical functions only. Contingency operations are not verified.

19.11 CREW FAMILIARIZATION

Refer to Section 5.4.

19.12 SERVICING MISSION GROUND TEST

SMGT-PCU (refer to Section 5.8) consists of a series of tests comprised of an AT and FT with the exception that the commands are generated from the STOCC instead of the VEST.

19.13 SYSTEM TEST

The flight PCU shall be installed in the VEST and used to support the system level testing (refer to Section 5.9).

19.14 PREPARATION FOR SHIPMENT TO LAUNCH SITE

The flight PCU in final flight configuration shall be inspected, photographed, and placed in the Hardigg container for transportation to KSC. Delivery to KSC will be on an air-ride van.

APPENDIX A

SM3 I&T VERIFICATION REQUIREMENTS

A.1. SM3 I&T VERIFICATION REQUIREMENTS

This appendix contain Table A-1, a matrix of SM3 I&T verification requirements common to multiple ORUs, but not all. The requirements shown in column one are derived from the indicated paragraphs of the higher level documents shown in column 2. Specific requirements for individual ORUs shall be derived based on this matrix and the verification requirements outlined in the respective ORU CEI Specifications. Column 3 shows the I&T test/ demonstration by which the requirements shall be verified.

Table A-1. SM3 Integration and Test Verification Requirements

Requirement	Doc/Para. Reference	I&T Test
Static Envelopes Static Envelope dimension for the OTA ES are shown in Fig. 3.3.2-3 (of ST-ICD-01). . . . Static envelope dimensions for the SSM equipment platform and equipment thereon are shown in Fig. 3.3.2-8 (of ST-ICD-01).	ST-ICD-01/ 3.3.2	Mechanical Interface Test
In-Orbit Changeout Operations. EV crewmember interface clearance envelopes for in-orbit ST ORU changeout operations are shown in Figs. 3.3.11-1 through 3.3.11-3.	ST-ICD-01/ 3.3.4.4e	Mechanical Interface Test
Operating Voltage Normal 24 to 32	ST-ICD-01/ 3.7.3 STR-01/ 3.3.3.5	SFT (Demonstration)
In-Rush Current. The rate of rise and fall is no more than 6 amps/ usec. The inrush current profile (applicable at 30 +/- 0.5 V) shall be within the envelope of Fig. 3.7.7.2-1 of ST-ICD-01.	ST-ICD-01/ 3.7.7.2	IVT
Grounding. Unregulated power and power returns are isolated from structure or chassis by 1 megohm or greater. Secondary power returns and signal returns may be locally grounded to chassis (preferably at a single point).	ST-ICD-01/ 3.7.8	EICIT
Grounding. Unregulated power returns are connected to the SSM Single Point Ground (SPG) and are isolated elsewhere from the ST skin by 1.0 megohm minimum.	ST-ICD-01/ 3.7.8a STR-01/ 3.3.3.3 STE-01/ 3.3.1.3	EICIT
Isolation. All power returns must be isolated from all signal returns.	STR-01/ 3.3.3.3	EICIT

Table A-1. SM3 Integration and Test Verification Requirements (Continued)

Requirement	Doc/Para. Reference	I&T Test
Electrical Bonding. Structure, equipment enclosures, skins, metallized thermal surfaces, removable doors, etc., are electrically bonded to the system via the mechanical attach points. The dc resistance across any electrically bonded point is less than 2.5 milliohms. However, items requiring bonding only for the prevention of static charge buildup are bonded and limited to a maximum of 1.0 ohm.	ST-ICD-01/ 3.7.9.1	Per Work Order Authorization.
Receiver EMI Requirements. Each high level discrete command receiver circuit meets the following EMI requirements: (2) The receiver circuit functions with a pulse of 21 volts amplitude and a duration of 22 milliseconds, with a 500 microsecond rise time applied to the input lines.	ST-ICD-01/ 3.7.9.3.(2)	IVT (Demonstration)
Differential Signals. Signal Source. The signal source is a National Semiconductor DS 7830 line driver. Each output line of the differential driver has a 43 ohm ±2%, 1/4W resistor in series in the line.	ST-ICD-01/ 3.8.2a	SFT (Demonstration)
Differential Signals. Signal Receiver. The signal receiver is a National Semiconductor DS 7820A line receiver.	ST-ICD-01/ 3.8.2b	SFT (Demonstration)

Table A-1. SM3 Integration and Test Verification Requirements (Continued)

Requirement	Doc/Para. Reference	I&T Test
Differential Signals. Logic Levels. The differential logic levels are controlled by connection of Line A (AND) and Line B (NAND) driver outputs to the (+) and (-) inputs of the receiver. The interface is wired by either interconnect (options 1 and 2) for logic compatibility with the SSM and OTA receivers. See Fig. 3.8.2-1 (of ST-ICD-01).	ST-ICD-01/ 3.8.2.c	IVT (Demonstration) EICIT (pinouts)
Diff. Signals. Rise Time/Fall Time. The rise/fall time of the DS 7830 output pulse is 100 nanoseconds, maximum, between the 10 and 90 percent amplitude points in accordance with Fig. 3.8.2-2 (of ST-ICD-01).	ST-ICD-01/ 3.8.2h	IVT (Demonstration)
High Level Discrete and Low Level Discrete Command messages. The message formats and timing for these types of commands are shown in Fig. 3.8.2-8, (of ST-ICD-01).	ST-ICD-01/ 3.8.2.3.5.2	IVT SFT (Demonstration)
Serial Digital Data Request Message. The formats and timing for this type of Data Request message are shown in Fig. 3.8.2-9. The data bits on the Request Line are coincident with corresponding clock pulses on the Clock Line. The data bits on the Reply Line are delayed on half a clock period. The individual message bit functions are shown in Table 3.8.2-3 ("X" indicates either "1" or "0").	ST-ICD-01/ 3.8.2.3.5.3	IVT SFT (Demonstration)

Table A-1. SM3 Integration and Test Verification Requirements (Continued)

Requirement	Doc/Para. Reference	I&T Test
Analog and Bi-Level Data Request Message. The message formats and timing for these types of Data Request messages are shown in Fig. 3.8.2-10. The data bits on the Request Line are coincident with corresponding clock pulses on the Clock Line. The data bits on the Reply Line are delayed one half a clock period. The individual message bit functions are shown in Tables 3.8.2-4 ("X" indicates either "1" or "0").	ST-ICD-01/ 3.8.2.3.5.4	IVT SFT (Demonstration)
SSM HLD Characteristics. The high level discrete characteristics are listed below and shown in Fig. 3.8.3-3a (of ST-ICD-01).	ST-ICD-01/ 3.8.3.1a	IVT SFT (Demonstration)